(iii) Pectin grade 250 at the rate of 50 PPM.

(iv) Corboxy methyle cellulose at the rate of 250 PPM.

(v) Homogenization at the rate of 7000 PPM.

(vi) ph. was adjusted between the range of 2.00 to 6.00.

(vii) Chelating agent (Na Po3) $_6$ was added at the rate of 0. 10%.

Conventionally prepared orange squash had maximum proportion of precipitat,e whereas, pasteurized squash contained about half of this amount. Homogenization caused further reduction in the amount of precipitate. Pasteurization produced major effect in stabilizing the colloidal system. Homogenization also made some positive effect in this respect. Addition of chelating agent (E.D.T.A., sodium hexa methapo sphate) in combination with C.M.C. at pH 4—5 gave some encourging results regarding control of cloud loss.

The results of this experiment revealed that complete success in stabilizing the cloud in orange squash could not be achieved by introducing different treatments in the processing operations.

9. Effect of Different Food Additives on Stability of Orange Squash During Storage.

The characteristic colour and flavour of orange squash is largely due to suspended meterials consisting of finely dispersed components, semi-solid particles in addition to colloidally dissolved constituents and chromatophores. Prolonged storage of squash at room temperature brings marked change in colour and flavour which is objectionable from organoleptic point of view. The following food additives were tried in different proportions and combinations to overcome the problem of quality deterioration of orange squash.

i) Ascorbic acid @ 500 PPM.

ii) Butylated hydrozy toluene @ 100 PPM

iii) Beta carotene @ 100 PPM.

iv) Corn syrup 25—90 percent as substitute of sugar.

Beta carotene was found to be on the top of the list for stabilizing the colour of orange squash after one year storage followed by ascorbic acid and butylated hydroxy tolune. The combination of beta carotene and BHT resulted not only in colour stability but also helped in flavour retention. Corn syrup upto 50% replacement gave hopefull results regarding colour stability.

Research work was also carried out on the following projects:—

1. Extraction of pectin from citrus peel and pulp.

2. Suitability of different curing agents and date varieties for curing pruposes.

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3. Effect of vacuum concentration on the quality of orange/Kinnow juice during storage.

4. Development and evaluation of instant/drinks.

5. Effect of dehydration on the quality characteristics of tomato powder during storage.

6. Dehydration of different vegetables.

7. Production of mango flavoured milk.

8. Fermentative preservation of vegetables and microbiological examination of processed food products etc.

II: Teaching and Demonstration Programme.

It has been estimated that 15-20percent of fruit and vegetable produce is wasted in our country and its cost comes to about Rs. 80 crores per annum. The manufacture of fruit and vegetable products like jams, jellies, squashes and preserves etc. can provide a safety valve for the fruits and vegetables which does not find a ready market and are wasted. Domestic level preservation of fruits and vegetables can easily save 50 percent wastage as is being practised in other countries like India. This will not only provide a variety of food products but will also help to save the country from the nutritional losses taking place in the country. Therefore, fruit and vegetable preservation techniques were demonstrated at different places. Peoples from different walks of life attended these training programme in respect of fruits and vegetables preservation at domestic level.

III: Production Programme.

The pilot plant shifted from Kallurkot to Faisalabad has been commissioned for the poduction of differenet processed food products for sale to the consumers in order to provide low cost processed food products in addition to assessing the laboratory findings through pilot plant production before releasing the formulaes for adoption by the industrialists. The commercial production has got educational value for the industrialists and also help in popularizing the use of processed food products among the masses in addition to rendering advice and solving the problems faced in commercial production.

COMPARATIVE STUDIES OF SOLAR DEHYDRATORS

by

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ABSTRACT

Efficiency of various solar dehydrators for preservation of different vegetables was studied. BCSIR modified model with black lining, cot and UNICEF model produced better results than open sun drying.

INTRODUCTION

Several methods are being practiced for preservation of various food stuffs. These range from open sun drying to sophisticated high frequency electronic dehydrators. Solar dehydration is a techniqne of recent origin and is considered to be the cheapest in countries with plenty of sunshine. Solar dehydrators have been designed and fabricated by various research workers and organizations. Their efficiency has also been tested[1,2]

Pakistan having plenty of sunshine and abundance of fruits and vegetables during peak seasons can preserve those for future use by making efficient solar dehydrators. The present attempt is a step in this direction.

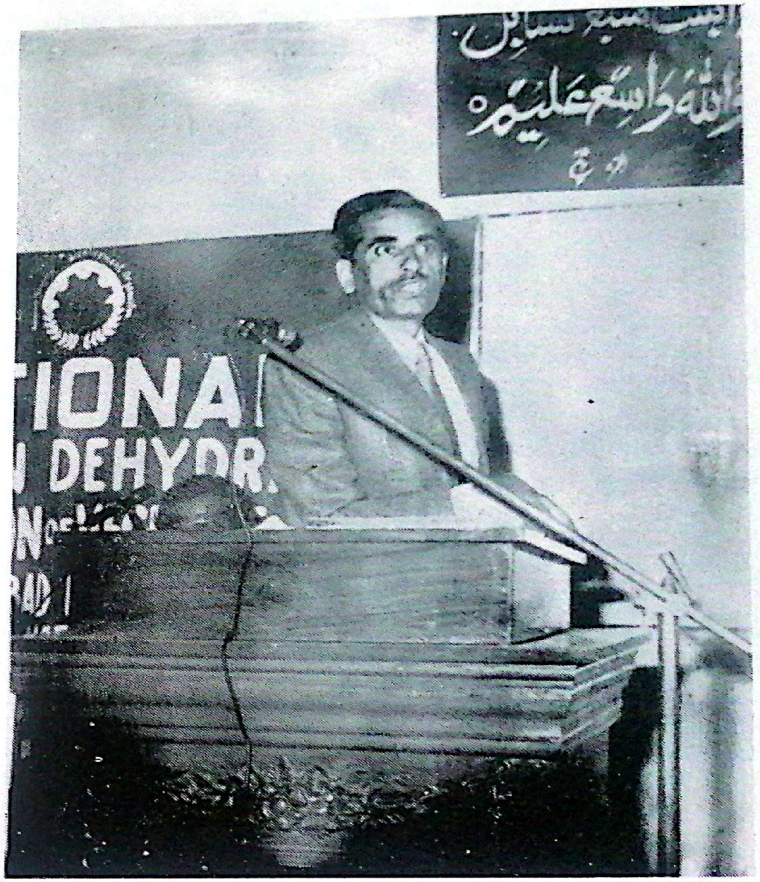
MATERIALS AND METHODS

Fresh vegetables were purchased from the local market and were prepared for dehydration, according to methods described by Cruess[3].

The prepared vegetables were loaded on to trays, (70 x 30 cm size) made of "Sarkanda" *(Saccherum arundinoceum)*, at the rate of 8 kg /m^2.

A. Dehydrators

Besides open drying four types of dehydrators were used for reduction in moisture contents.



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1 **BCSIR modified Model**

It is a portable type dehydrators, made of conduit pipe which can hold three trays (70 x 30 cm). The dehydrators is covered with polythene sheet cover provided with holes for the inlet of dry air and out-let of saturated air.

2. **BCSIR modified Model with Black Lining**

It is the same model as described above but is covered on three sides with black coton cloth leaving the front side exposed to the sun.

3. **UNICEF Model**

It is a non-portable dome shaped model made of bricks and bamboo sticks. A rectengular base is made with bricks and bamboo sticks in the curved form are fixed to the base. The rectangular base is partially filled with pebbless and whole construction is covered with polythene sheet. Trays, loaded with prepared vegetables, are placed inside the rectangular on pebbles.

4. **Cot**

A cot made of wood and wound fibre strings was placed upside down. The bottom was covered with black cotton cloth on which the vegetables were spread at the rate of 8 kg/m^2. The black cloth was also wrapped along three sides leaving the front side exposed to sun. The upper portion of the cot was covered with polythene sheet.

All the dehydration experiments were started at 8'o clock in the morning. Temperature, relative humidity and moisture contents were recorded at an interval of 2 hours uptil the termination of the experiments.

B. Microbial load

Total and viable counts of the fresh and dehydrated vegetables were determined according to the method described by Baker[4].

C. Rehydration

Leafy dehydrated vegetables were rehydrated by boilling them in water for 5 minutes, while okra, bitter gourd and capsicum were kept in boling water for 8 minutes. Rehydration ratios were calculated from the following relation[5].

$$\text{Rehydration Ratio} = \frac{\text{Rehydrated wt.} - \text{Dry wt.}}{\text{Dry wt.}}$$

RESULTS AND DISCUSSIONS

1. **Effect of type of solar dehydrator on dehydration of various vegetables**

Results of moisture content of fresh as well as dehydrated vegetables, temperature and

relative humidity ranges and dehydration time for various vegetables are reported in Table-I. Efficiency of various types of dehydrators is evident from the dehydration rate of vegetables included in these experiments. Dehydration time for each vegetable was determined by conducting preliminary experiments on individual vegetable. Therefore, each vegetables was exposed to solar dehydration for such a period of time, so that it was dehydrated to a desired moisture level. This time may very with variation in weather conditions. This parameter also varies considerably with various vegetables, e.g., in open sun drying 10 hrs were required to achieve 16.3% moisture content of okra, while it took only 2 hrs to dehydrate coriander to 12.0% (Table - I). Therefore, individual vegetable was dehydrated for a fixed predetermined period of time and then efficiency of determined.

It can be observed from the results presented in Table - I, the BCSIR modified model with black lining, UNICEF Model and cot were comparable. In some cases BCSIR modified model with black lining showed better results in terms of dehydrating vegetables to lower final moisture content, while in other cases cot and UNICEF model were more efficcient. However, from on-the-shelf storage point of view, these three dehydrators brought all the vegetables, included in these experiments, to a safe moisture level.

2. **Effect of different type of solar dehydrators on microbial load of dehydrated vegetables**

Total and viable count of fresh and dehydrated vegetables were determined. It may be observed that vegetables dehydrated BCSIR modified model with black lining, UNICEF model and cot showed lower microbial load on dehydration as compared with model I (Table - II). This is obviously due to the difference in temperature ranges during dehydration. BCSIR modified model could attain lower temperature (Table - I) as compared with the afore-mentioned three dehydrators. The highest viable count wasfound in the open sun drying, again this was due to low drying temperature as compared with the different models of solar dehydrators and direct contact of the vegetable with dust and microbes present in the air.

3. **Rehydration charateristics of dehydrated vegetables**

Rehydration studies were carried out just after the dehydration experiment, i. e., storage factor was not involved. Results (Table - III) showed that water absorbing capacity of open sun-dried products was better as comared with the samples dehydrated in solar driers. BCSIR modified model showed higher rehydration values as compared with the other three dehydrators, while samples dehydrated in UNICEF model showed the lowest rehydration values. These variations in water absorption capacity of various samples might be due to variation in dehydration temperatures. Samples dehydrated under higher temperatures could absorb lesser amount of water of rehydration. Higher dehydration temperatures might have adversly affected cells/tissues of the vegetables, resulting in lesser water absorption capacity of these samples.

4. **Couclusion**

BCSIR modified model with black lining, UNICEF model and cot were the three efficient

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units amongst the dehydrators employed in these studies. BCSIR modified model and cot were mobile units; while UNICEF model was a fixed dehydrator. Moreover, UNICEF model would be an expensive unit to fabricate as compared to the rural areas would be an additional merit for adopting it for solar dehydration. Therefore, BCSIR model and cot may be preferred over UNICEF model in Pakistan.

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Table-I

Effect of type of solar dehydrator on dehydration of various vegetables

Vegetables	Moisture Before Dehydration %	Open sun Drying			BCSIR modified model			BCSIR modified model with black lining			UNICEF model			Cot		
		Drying Temp °C	Dry Time (hr)	Relative humidity %	Moisture %	Drying Temp. °C	Drying Time (hr)	Relative humidity %	Moisture %	Drying Temp. °C	Drying Time (hr)	Relative humidity %	Moisture %	Drying Temp. °C	Drying Time (hr)	Relative humidity %	Moisture %
Bitter Gourd	91.8	45-48	5	56-53	15.0	50-59	5	49.35	6.5	60-70	5	38-28	5.7	60-70	5	38-28	5.8	57-69	5	42-29	5.7
Cabbage	00.0	45-50	5	56-49	17.9	55-61	5	47-38	6.8	60-69	5	38-29	4.6	60-70	5	38-28	5.8	51-68	5	40-30	5.8
Capsicum	85.0	45.50	10	56-49	16.4	50-60	10	49-40	10.4	59-73	10	39-25	7.8	60-73	10	38-25	7.6	58-72	10	40-25	7,7
Coriander	87.8	45-50	2	56-49	12.0	50-55	2	49-46	5.6	58-68	2	40-30	4.7	60-70	2	38-28	5 0	58-68	2	40-30	4.9
Mint	84.4	40-48	3	67-53	10.0	50-52	3	49-46	6.0	55-61	3	46-39	5.0	55-61	3	46-39	4.5	55-60	3	46-39	5.2
Okra	86.8	45-48	10	56-53	16.3	50-58	10	49-36	7.8	60-75	10	40-23	7.4	62-75	10	36-23	7 0	58-72	10	40-25	7.7
Spinach	88.5	45-55	6	56-49	11.9	55-60	6	49-40	5.5	60-60	6	40-30	5.4	60-70	638-28	5.0	58-68	6	40-30	5.3	

Table-II

Effect of type of dehydrator on microbial load of fresh and dehydrated vegetables

Vegetables	Microbial load Before Dehydration		Microbial Load After Dehydration									
			Open sun Drying		BCSIR modified model		BCSIR modified model with black lining		UNICEF model		Cot	
	Total Count	Viable count	Total count	Viable count	Total count	Viable count	Total count	Viable count	Total count	Viable count	Total count	Viable count
Bitter gourd	1.2×10^5	2.0×10^4	1.2×10^5	1.0×10^4	1.2×10^5	1.8×10^3	1.1×10^5	2.0×10^3	1.1×10^5	2.0×10^3	1.2×10^5	1.9×10^3
Cabbage	2.4×10^5	1.0×10^4	2.4×10^5	1.8×10^3	2.4×10^5	1.9×10^2	2.4×10^5	1.5×10^3	2.4×10^5	1.3×10^3	2.4×10^5	1.5×10^3
Capsicum	3.0×10^5	1.6×10^4	3.1×10^5	2.4×10^3	3.0×10^5	1.8×10^2	3.0×10^5	1.6×10^3	3.0×10^5	1.5×10^3	3.0×10^5	$1,6\times10^3$
Coriander	2.5×10^5	5.5×10^3	$2,6\times10^5$	1.4×10^3	2.5×10^5	1.5×10^2	2.5×10^5	1.3×10^3	2.5×10^5	1.2×10^3	2.6×10^5	1.4×10^3
Mint	2.0×10^5	6.0×10^3	2.1×10^5	2.5×10^3	2.0×10^5	2.0×10^3	2.0×10^5	1.5×10^2	2.0×10^5	1.5×10^3	2.0×10^5	1.4×10^3
Okra	3.0×10^5	3.1×10^4	3.0×10^5	2.0×10^3	3.0×10^5	1.4×10^2	3.0×10^5	1.1×10^3	3.0×10^5	1.2×10^3	3.0×10^5	1.2×10^3
Spinach	3.2×10^5	1.5×10^4	3.2×10^5	1.5×10^3	3.1×10^5	1.7×10^3	3.1×10^5	1.6×10^3	3.2×10^5	1.4×10^3	3.2×10^5	1.6×10^3

Table-III

Effect of type of dehydrator on rehydration characteristics of vegetables

Vegetables	Dehydrators				
	Open sun drying	BCSIR modified model	BCSIR model with black lining	UNICEF model	'Cot'
Bitter Gourd	4.2	4.1	4.0	4.0	4.1
Cabbage	4.3	4.1	4.0	4.0	4.1
Capsicum	—	2.5	2.5	2.4	2.5
Coriander	4.4	4.0	3.8	3.8	3.8
Mint	4.1	4.0	3.8	3,6	3.8
Okra	3.8	3.5	3.4	3.4	3.6
Spinach	4.2	4.0	3.8	3.6	3.8

DEHYDRATION AND PRESERVATION OF FRUITS & VEGETABLES

NEW STRATEGIES IN VEGETABLE PRESERVATION

By

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INTRODICTION

The storage of vegetables like potatoes, onions etc is a serious problem during the hot summer months. They are completely destroyed by rot attack within 4-6 weeks, if stored at ambient room temperature 30-40°C. Therefore, the products should be stored at low temperatures. Good storage should prevent excessive loss of moisture, development of rot and excessive sprout growth. Although insects and microbes are also responsible for spoilage of these vegetables, the major problems in this case are sprouting and rotting which result in colloSal damage to these commodities. The problem of rot incidence with loss and sprouting can be overcome provided storage of the spring harvest is done at low temperaure (below 4° C). Storage at this temperature causes the accumulation of reducing sugars in the tubers which give undesirable colour and taste to the roasted and cooked products. At the same time the prices of cold storage vegetables rises so high, that it is beyond the purchasing power of a poor man. Moreover, in Pakistan cold storage facilities are very inadequate and are still in their infancy. Micro-organisms are active at ordinary room temperatures, 20° C-30° C, multiplying rapidly and causing profound changes in vegetables. At low temperature their growth is reduced until at about-10° C, their growth becomes negligible. Chemical and enzymatic actions which occur rapidly at room temperature take place very slowly during cold storage. The lower the temperature of storage, the more slowly these actions occur and below 41° C little change occurs even in a year(1).

Radiation has proved to be a potent tool for the extension of the shelf life of certain fruits and vegetables. Many investigators have established the possibility of controlling sprouting in potatoes, onions and garlic by radiation and have proved the superiority of this technique (2,3).

Extensive research has been carried out in several international laboratories to establish the wholesomeness of irradiated food (4). The third Joint FAO/IAEA/WHO Expert Committee on the wholesomeness of Irradiated Food held in August/September, 1976 in Geneva was able to recommend on the basis of all available data including those provided by IFIP, the unconditional acceptance of

to wholesomeness of irradiated potatoes, wheat chiken papaya and strawberries. It also gave provisional approval for irradiated rice, fish and onions (2).

A number of countries have given approval for the radiation preservation of foods based on the wholesomeness and consumer acceptability of the irradiated products and feasibility of the technology.

In recent experiments in our laboratories lower levels of gamma radiation were worked out for complete inhibition of sprouting in different varieties of potatoes, onions and garlic and garlic. The present work has, therefore, been conducted to investigate the effect of antisprouting agents (maleic hydrazide and CIPC) and antifungals (Thiabendazole and Benlate) on the storageability of various varieties of potatoes, onions and garlic stored at various temperatuees.

Materials and Methods

Potatoes of two varieties, Desiree and Ultimus, which were harvested four weeks earlier and stored, at about 20°C, were procured from the local vegetable market. Twenty kilorgrams of sound healthy tubers of medium size were selected for all the treatments in each case. The following treatments were given: gamma radiation (10 krad), CIPC (10 prm) TBZ, Benlate, TBZ + radiation and Benlate radiation. Portions from all these treatments in duplicate were stored together with control in two different temperatures ambient room temperatue (25-40°C) and R. H. 40-50% and low temperature (4-10°C) and R. H. 90-95%, for a period of 8 months. Potatoes, onions and garlic were irradiated with a dose of 10 krad in a Mark IV Irradiator with Co-60 source of 20,000 Ci. Visual observation of colour, texture, core condition, rot attack and sprouting of all lots were carried out at regular intervals throughout the experiments.

Local varieties of onions and garlic were used in these studies. They were procured within one week after harvest and 20 kg of sound, medium size bulbs were selected for each lot. The irradiated (10 krad) and control bulbs were stored under similar conditions to those mentioned above for observation of rot incidence and sprouting.

Results and Discussion

Potatoes

The visual observation revealed that Ultimus potatoes stored at room temperature, stored at room temperature, started rotting only two weeks after storage began irrespective of treatment all the lots of this variety were completely destroyed by rot attack after a storage period of 10 week whereas Desiree tubers were totally spoiled after 12 week storage. The evidence of nothing was not more than 2-3%, in various treatments of Ultimus stored at low temperature (4-10°C) upto a storage period of 16 weeks, whereas rotting was not more than 4-5% in all the Desiree lots. The antisprouts had little effect on the control of rot attack. Desiree potatoes with different treatments showed more or less the same trend, except that rot incidence was clearly less than in Ultimus potatoes at the end of 16 weeks storage. The percent of spoilage due to rotting in control and irradiated

Dr. Ismail Khan, presenting his paper.

tuders is shown in Fig.I. The microbiological examinations revealed that rotting was mainly due to Fusarium and Erwinia spp.

It was observed that rotting increased with increasing temperatuae potatoes showed a slighted tendency to rot during storage. According to some workers (13), the percentages of rotted tubers is irradiated lotes stored at 12, 20 and 26-32°C were 6- 11%, 18% and 55-61% respectively, whereas in controls the respective values were 4%, 17% and 59-61%. At lower temperatures, though irradiated potatoes showed a slightly higher rate of rotting, the differences were not significant. Moreover, no investigation so far reported in the literature has shown the oontrol of these rot organisms in potato tubers with the help of chemicals.

The irradiated Ultimus tubers, stored at 14-16°C, remained unsprouted. The CIPC-treated tubers showed very small sprouts. All other batches of this variety started sprouting after 6 weeks, storage. Desiree potatoes showed a very similar response as far as sprouting of the tubers was concerned.

The organoleptic evaluation of irradiated, CIPC-treated and control potatoes of both varieties, stored at low temperature for 20 weeks, revealed that chips and french fried potatoes from irradiated tubers were preferred to those from control and CIPC-treated ones.

The effect of gamma radiation on the chipping quality of potatoes has also been studied extensively. It has been concluded that there was no deterimental effect of radiation on the chipping quality and colour of the treated potatoes. In general, the results reported indicate that sprout-inhibiting doses of gamma radiation have no significant effect on the organoleptic properties of cooked or chipped potatoes. However, varietal effects were more pronounced than any irradiation effect. It is, therefore, recommended that only those varieties should be treated by radiation that have good cooking, chipping and storage properties.

ONIONS.

Sprouting was completely inhibited in the irradiated bulbs stored at ambient and at low temperature during the whole storage period. Our results are in agreement with the observations that a dose of 5-15 krad used shortly after harvest shows excellent sprout inhibition (6). However, these investigations do not confirm the findings of those that did not report complete inhibition of sprout in oniens at a dose level of 6-15 krad (7,8).

TABLE I.

INCIDENCE OF ROT ATTACK IN ONIONS STORED AT VARIOUS TEMPERATURES (% rotted bulbs)

Storage period (months)	Storage at low temperature		Storage at room temperature	
	Control	Irradiated	Control	Irradiated
1	—	—	—	—
2	—	—	—	—
3	10	5	25	20
4	21	13	29	30
5	22	15	35	36

TABLE II.

INCIDENCE OF ROT ATTACK IN GARLIC STORED AT VARIOUS TEMPERATURES (% rotted bulbs)

Storage period (months)	Storage at low temperature		Storage at room temperature	
	Control	Irradiated	Control	Irradiated
1	—	—	—	—
2	—	—	—	—
3	—	—	—	8
4	—	—	3	10
5	12	3	7	21
6	18	4	46	54

Holland W. Germany, Spain and India have also the facilities for irradiating foods on pilot plant scales. This gives an idea about the commercial exploitation of this modern technology in various comtries of the World (9).

Since the problem of food spoilage is quite/in Pakistan, it is emphasized that radiation technology should used commercially for food preservation. As we dont have any pilot plant irradiation in Pakistan, it is difficult to calculate the accurate cost economic of processing various foods by this method. However, an attempt has been made to give an estimate of installing a commercial food irradiator as well as the cost per ton of potatoes and onions. According to our estmiates the radiation treatment will cost of Rs. 10.00 per ton of potatoes, onions etc; (10).

Conclusion

It is concluded that radiation followed by storage at 14-16° C is the optimum condition to store potatoes, onions and garlic in good condition for more than 5 months in tropical countries like Pakistan. The desiree variety was found better than Ultimas for storage under the abovementioned conditions. Antifungals had little effect on the control of potato dry and soft rot. Gamma radiation was more effective than CIPC as an antisprouting agent for potatoes and had no adverse effect on the quality of stored products.

The prospects for the radiation preservation of potatoes, onions and garlic are very bright in Pakistan and all preparations are being made to adopt this technology on a commercial scale.

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TECHNOLOGY TRANSFER FOR DEHYDRATION AND PRESERVATION OF VEGETABLES & FRUITS IN RURAL AREAS.

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1. INTRODUCTION

Fruits and vegetable products have long been important articles of commerce and for many centuries have formed a large proportion of the diet of man. Many of these products were first prepared in the household on a small scale before their commercial production was undertaken and others since the beginning of their manufacture have been prepared on a factory scale.

The ever increasing spread of man over different parts of the world into widely different climates and still more the increase in urban population have rendered the development of efficient methods of preservation a matter of vital necessity. For many centuries the art of preservation was at a standstill or developed only slowly and was purely empirical, fermentation, drying, smoking or curing with salt being the principal methods. As the bilogical causes of food spoilage became better understood rapid advances followed and appropriate methods were gradually evolved for dealing with the causative agents.

The modern objective of food preservation includes more than the mere prevention of spoilage. Quality, economy and convenience are in most instances important in the production and marketing of processed foods. Colour or appearance, flavour, texture or consistency and freedom from defects are the major quality factors. Nutritive value has also come to be recognized as a quality factor.

Inspite of some of the early objections to processed food, it is now generally conceded that the increasing availability and use of processed foods has had a profoundly beneficial effect on the diet pattern in many countries and that in most instances it has led to substantial improvement in the national nutrition. This is particularly true where fresh fruit and vegetables are available only during part of the year.

for preservation of vegetables and fruits are quite old. Sun
known to ancient hunters and gatherers, who also used cave
mentation was known by the third millenium BC in Mesopo
developed in the ancient world. Modern methods of preservation
freezing developed early in the 20th century; follower
has played an increasingly important role in modern

IMPORTANCE OF FRUIT AND VEGETABLES

IN PAKISTAN

conditions of Pakistan are suitable for all types of fruits. The
a large number of fruit plants from their nurseries annually.
private nurseries also supply millions of fruit plants to the
during the season, there is considerable depression in
highest in summer and lowest in winter adversely effect
market is not equipped to balance these factors. Gener
near and far off markets for want of storage and
are thus glutted with fresh fruits, consequently
income to fruit growers. To overcome the
encourage the grower with better price and

grown in Pakistan throughout the year. However
season on account of number of reasons, mo
means of transportation. A limited quantity
cost is so high that it is beyond the purchasing
preserving vegetable, for the common man is to
equipment is needed for preserving vegetables
the space required by fresh vegetables. Moreover,
in bottles with screw top lids.

in Pakistan specifically by Pakistan Council
Agricultural Research Institutes etc. on the
vegetables and fruits. Therefore, there is a
community.

TECHNOLOGY.

wealth and prosperity of people all over the
structure and are the foundation of agriculture
modern countries. A country's

Mr. Hasan Mehdi Naqvi, presenting his paper.

may be judged by the extent of its technology development in various sectors particularly in the rural sector where majority of our population is involved in agriculture directly or indirectly. The developing countries are taking special care for the development and diffusion of new technology through various agencies, organizations and departments. However, a majority of the developing countries have not been an successful in adoption of new technology and innovations inspite of its availability in various fields like that of dehydration and preservation of vegetables and fruits.

An increasing variety of technologies are emerging and/or being developed within Pakistan and in other nations which if properly utilized can greatly increase productivity in rural settings and thereby ehnance the quality of rural life. It is essential that consideration be given to assure that there is no mis-match between technologies introduced and rural institutional capacities to absorb or utilized them. Rates of technological absorption will vary from locality to locality. However, studies reveal that Pakistan has a high absorption capacity, providing that technologies are introduced in a systematic manner. There is a need to narrow the gap between the development and the diffusion of technologies. Research and educational institutions in Pakistan have developed and pretested technologies which can be introduced in appropriate rural localities.

Agricultural Scientists, Experts of Extension Education and Social Scientists involved in developing rural people are not lacking in ideas and techniques for fostering the transferring of technological innovations. Obviously the question arises as to how and in what way technology transfer may be carried out in rural Pakistan.

IV : Techniques of Disseminating Information To Rural People.

1 Extension Services

In order to speed up agricultural development, the extension services provide uptodate information to rural people and help them in acquiring necessary knowledge through different methods in diffusion and adoption of improved technological innovations in the field of dehydration and preservation of vegetables and fruits. The extension staff may also hold meetings, conferences and group programmes and use different tools like method demonstrations, audio-visual aids etc., for fruits and vegetable preservation. The Extension Services of Agriculture Department can also hold short courses in dehydration and preservation of fruits and vegetables for farmers with the collaboration of Research Institutions.

2. Research Institutions

The Agricultural Research Institutes and other related institutions in Pakistan should render advice and solve the problems encountered by the food processing industries. In addition they should also educate the farmers and rural people to develop it as Cottage Industry in the country. The Research Institutions should also develop simple technology for the use of rural people.

...country can also share the responsibility in diffusion of ... education to high school students particularly girls ... Quaid-i-Azam University, Islamabad can also play a vital role by their corresp... ...educating the rural masses.

... people through mass media

...languages play a vital role in educating rural people. The leaflets, ... handouts, news magazines can prove useful if prepared systematically.

...

...stimulate, sell ideas, induce belief, create and change attitudes. Specific ... broadcast once in a week on dehydration and preservation of vegetables ... languages. Although television is not very common in the rural areas, it is a useful ... regarding food preservation. Carefully planned educational ... using visual aids can be used in educating rural population. These types of ... every month or fortnightly for a duration of 15—20 minutes.

... and magazines

... important role in transferring technology for fruit and vegetable preservation. ... magazines may contain useful articles, features, special supplements on food ... the use of rural community.

... and festivals

... fairs, exhibits and festivals take place at regular intervals in our country. The ... workers and change agents may have their stalls where they can demonstrate ... involved in preservation.

... of local leaders[1]

... can be utilized in the diffusion and adoption of innovations in the field ... in our country. From the sociological point of view leaders act as catalysts ...

... Hasan Mehdi Naqvi, Techniques of training local leaders and change agents and ... in Rural People in Rural Development Training to meet new challenges, Volume ... and L.J. Fredricks, Asia and Pacific Development Administration ...

to help their group members, to create awareness and utilize their potential. From an economic viewpoint, economic growth will not be fully successful if local leaders are excluded in the planning and execution of different development programmes. From educational stand point, local leaders are of great help in introducing social and technological changes in rural society. Local leaders can be useful agents to reach the rural poor. These leaders have several advantages over outsiders. Short courses can be carried out by extension and research workers at researchs tations, Local Government and Rural Development/IRDP Marakaz Agricultural, Institutes Colleges, Universities, Local Government Institutions and rural Academies etc. Local Leaders my be trained for a period of 2 to 4 weeks. The local leaders can further disseminate useful information to their fellow farmers at their villages.

6. Extension education/training under Daudzai IRDP approach[2]

Upgrading the skills of the rural population is considered to be one of the important prerequisites for their development, Under Daudzai Markaz approach to rural development, a Model Farmer is chosen by the village cooperative organization as its representative. These representatives are regularly imported instructions in various fields of agriculture by the markaz functionaries (Experts) according to a training calender[3] keeping in view the cropping season, needs and requiremtnts of rural people. These Model Farmers and other cadres further orientate their fellow members about the subjects, learnt from the experts of the Markaz, in their weekly village meetings. Thus each group gets its own extension agents who are professional fellow farmers. The 32 other IRDP Marakaz in NWFP follow this pattern. This approach can easily be followed in whole of the country which can further help in disseminating technology for dehydration and preservation of vegetables and fruits in rural areas. The Model Farmers can be trained through various techniques and methods by providing necessary facilities at IRDP or Local Government and Rural Development Marakaz.

7. Training Pesh Imams

Ulema and Pesh Imams can also play a vital role as local leaders and change agents as theory have great influence in our society. Moreover, they have an opportunity of meeting rural people at least five times a day in village mosques. Short courses can be arranged by experts and extesion workers for them in dehydration and preservation of vegetables and fruits in rural areas. They can further educate other members of the community-

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2. For details see : Akhtar Hameed Khan, Minhajuddin Khan and Feroz Shah, "A Review of Daudzai Pilot Project 1972-74". Journal of Rural Development and Administration, Volume XI, No 2, April-June, 1978: Pakistan Acadmy for Rural Development, Peshawar: pp. 20-22.

3. For details see. Hasan Mehdi Naqvi, "Training Calender July 1975 - June, 1976" (Urdu). Pakistan Academy for Rural Development, Peshawar (mimeographed).

8. Training of rural women[4]

The women in rural areas can play an important role in this field. They should be trained at village level as being done successfully in other traders at the Women Village Home (vocational, health) set up under Integrated Basic Services for Women with the financial assistance of UNICEF in Daudzai Markaz by Pakistah Academy for Rural Development, Peshawar. Suitable training institutions should be established at the village level to impart technological skills to women.

9. Training Youth [5]

For childern still at school, activities for fruit and vegetable preservation, can be organized with the assistance of school administration after forming youth clubs. For those who have left school, separate village clubs can be organized for boys and girls. The principle on which the clubs would operate would be "learning and earning". Specific skills can be imparted by extension workers, school teachers or retired educated persons in the village. Motivation of club participants could be encouraged by inter-village competitions. These clubs may also have other activities like vegetable growing, bee-keeping, sericulture, vaccination of poultry, grafting and hudding of trees in addition to fruit and vegetable preservation.

V. Conclusion

With the widespread use of science, technology, institutions and better communications between rural and urban sectors, there is an increased demand for transferring of technology in the fields of dehydration and preservation of fruit and vegetable in the rural areas. It is believed that enough potential technological innovations are available in the country which can be diffused in the rural community. Modern agriculture involves application of new discoveries in science and technology on the one hand and use of the principles of business and industry on the other hand, thus the terms, agro-science, agro-technical, agro-business and agro-industry. Therefore, to get maximum net income from agriculture, all principles of science, technology, business and industry have to be applied simultaneously. It is imperative that all individuals, organizations, educational institutions and nation building departments, concerned directly or indirectly with the rural development must contribute their due share towards achieving the national objectives. The rural masses have to be imparted training and education in (a) common methods of fruit and vegetable preservation, (b) canning and bottling of fruits and vegetables. (c) preparation of juices, squashes, jam, jellies and marmalades, (d) drying of fruits and vegetables and (e) making of pickles etc.

Cottage industries for fruits and vegetable preservation are essential for increasing the income of the rural people. These cottage industries can provide full time employment to un-employment and partial employment to the under-employment. Since agriculture is a seasonal occupation, majority of the farmers can also benefit from this cottage industry. An important step in promotting this rural industry is to establish a small preservation unit at the Markaz level. This will create the proper infrastructure for technical guidance, education and marketing.

Further, persons going in for such activities should be provided all the infrastructure support including credit from cooperative banks, equipment, material and literature etc. There is also a need to develop appropriate technology in a simple way in order to popularise the dehydration and preservation of fruits and vegetables amongst the rural community

4. For further details see: Minhajuddin Khan, "The Role of or on Cooperatives in improving nutritional Status presented in the Third Asian Congress of Nutrition, Jakarta, Indonesia, October, 1980.

5. For further details see. Reports of International Seminar on Basic Needs strategy for Rural Development and Inrernational Workshop on Training for Rural Development, Pakistan Academy for Rural Development, Peshawar 1979. pp. 58-59.

POST HARVEST STUDIES ON CITRUS* AND MANGOES**

By

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Abstract

Post-harvest studies on the effects of gamma irradiation, chemicals, waxing and packaging materials on citrus fruits and mangoes were carried out both at refrigerated and non-refrigerated storage temperatures. These studies were carried out on commcerial cultivars viz. 'Feutrell's Early' and 'Kinnow' mandarins; 'Eureka' lemon, 'Jaffa' 'Pineapple' and 'Valencia' oranges, and 'Marsh' grapefruit. In mangoes the cultivars under study were 'Desi', 'Dusehri', 'Mohammadwala' and 'Samar Bahshit'. Physiological, biochemical, micro-biological and organoleptic examination of treated and untreated fruits were carried out at subsequent intervals and data analysed statistically. The results of this studies on citrus fruits and mangoes have been summarized in this paper.

1. Introduction

Citrus and mangoes are among the major fruits produced in Pakistan with annual production of 795.6 and 647.3 thousand tons, respectively (1). Due to inadequate handling, transport and storage facilities and further lack of technical "know-how", about 10-15% of the produce is spoiled from tree to the table (23), and this loss tunes to millions of rupees annually. Post-harvest deterioration of fresh fruit is due to loss of moisture from fruit surface resulting in shrivelling, faster respiration resulting in senescence and physiological and phathological diseases resulting in rot. If the fruit is carefully picked at the right time of maturity and these factors are looked into properly, we can extend their shelf-lines and also reduce post-harvest decay. With these objectives in view, we started a research project on citrus and mangoes, the results of which are given here.

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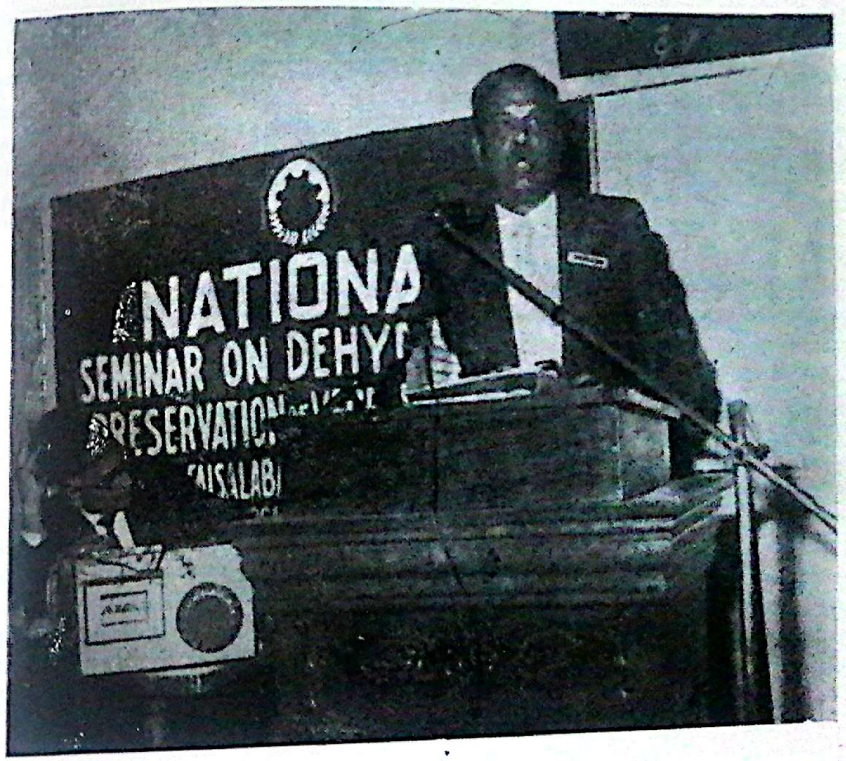

Mr. W. A. Farooqi, presenting his paper.

2. Citrus

2. 1. Effect of gamma irradiation

Some experiments on radiation presevation of 'Pineapple' and 'Jaffa' oranges (9) and 'Kinnow' mandarian (10) were carried out and the fruits were subjected to.100, 200 and 300 Krad doses. Radiation was carried out in a Gamma cell 220 (60 source), the fruits were held in boxes lined with newspaper stored at room temperature ranging from 18-25°C. In one of the experiments on Kinnows, irradiated and unirradiated fruits were also stored under refrigerated storage (5-7°C). Data on physico-chemical analyses were collected at subsequent intervals using standard techniques for the estimation of total soluble solids, total acidity, ascorbic acid, sugars, carotenoides and pectin fractions (7, 19, 24, 25). The organoleptic evaluation was carried out by a panel of judges using constituents were recorded as an effect of radiation, Gamma irradiation does of Krads and above caused skin damage to the peel in the form of 'pitting' (10), therefore, the work on the application of some other post-harvest techniques was continued.

2. 2. Effect of thiabendazole in conjunction with packaging materials

Experiments on this aspect were carried out in mid 70's)12) when washed Kinnows were dipped in an aqueous suspension of thiabendazole (TBZ) using 5000 ppm concentration prepared from Tecto-40 Flowable, (a product of Merck, Sharp and Dohme of Pakistan Lted.) Kinnows were immersed in the suspension for 2 minutes at room temperature and then dried. Both treated & untreated fruits were held in preforated boxes lined either with tissue paper, wax paper or thin polyethylene (PE) film (17). The containers were then stored at room temperature (18)-20°C) also in the cold room (5-7°C) for 5 and 10 weeks, respectively. Biochemical estimations were carried out using the methods mentioned obove. The TBZ residue in the peel and pulp of the stored Kinnows were estimated by the method described in AOAC (7). The microorganism responsible for the decay were isolated and identified (12). Weightloss of Kinnows was significantly ($P < 001$) reduced using PE liners, followed by wax paper, and tissue paper. The decay organisms were identified as *Penicillium digitatum* (green mold (and *P. italiacum* (blue mold). Dipping of fruit in TBZ helped to control the rot significantly ($P < 0.00$). in some of the fruits stored for 10 weeks, *Alternaria citri* caused internal blackening in Kinnows & TBZ was not found effective in controlling this problem (14).

2.3. Effect of wax-coatings:

Effect of wax-coatings using a local wax emulsion 'Fruitex' (a product of PCSIR) was studied on Kinnows and also on oranges when washed fruits were dipped in the wax emulsion for 2 minuts and dried. The fruits were held in boxes lined with newspaper and stored at refrigerated and non-refrigerated temperatures 3,4). The evaluation of waxed and unwaxed fruits was done by the methods mentioned earlier.

Wax coating helped to check weightloss significantly ($P < 0.01$). Dipping fruit in the fungicidal wax emulsion reduced fruit rot ($P < 0.001$). Like TBZ, waxing of fruit had no significant effect on

the control of internal blackening. Wax-coated fruits developed some off-flavour during storage at higher temperatures (18-21°C) which could become a problem during marketing.

2.4. Development of a new process

In order to overcome the problem of off-flavour development in wax-coated fruits and to find an effective control of internal blackening, further studies were carried out in our laboratory. As a result of these efforts a process for the preservation of 'Kinno' was developed (15) which helped to keep the fruit fresh for about 5 weeks at room temperature (18-20°C) and 10 weeks in the cold room (5-7°C), with encouraging results on Kinnows, this method of preservation was also tested on some other commercial citrus cultivars viz. 'Foutrell's Early' mandarin, 'Euraka' lemon, 'Marsh' grapefruit and 'Valencia' oranges, both at refrigerated and non-refrigerated temperatures (16). The preserved fruit was considered (by a panel of judges) significantly superior than control fruits. Valencia oranges gave a fresh look after storage of 5 months in the commercial cold storage.

2.5. Control of internal blackening

As described earlier, neither TBZ nor 'Fruitex' could control the problem of internal blackening caused due to Alternaria citri. An antifungal complex (AFC) obtained from local strain of Bacillus subtilis AECL-69, which inhidited the growth of A. citri isolate on petri plates (22), was tried on oranges and mandarins. The concentrations of AFC and its application was standardized in this laboratory and successfully applied on 'Valencia' oranges (18). Further work on the residual effects of this antibiotic and application of 2 new American wax emulsions for the shelf-life of citrus fruits is in progress.

2. MANGOES

3.1. Effect of gamma irradiation

Effect of gamma irradiation on the shelf-life extension of 'Desi' (6). 'Dusehri' (2), Mohammad 'wala' (20) and 'Samar Bahshit' (11) mangoes was studied during storage at room temperature. A dose of 30 krad was found optimum for delaying the ripening of hard green mangoes for 5 days. The irradiated mangeos remained green ($P<0.01$) than unirradiated mangoes. No deleterious effect on biochemical parameters was recorded as a result of the treatment at this radiation dose.

3.3. Effect of packaging

In order to examine the effect of packaging on the quality of stored mangoes, a study on 'Samar' Bahshit' (11) mangoes was carried out in which mature hard green mangoes were held in wooden boxes lined either with tissue paper, newspaper, wax paper or polythylene film (PE). weight loss of mangoes was significantly ($P<0.001$) reduced when (PE) was used as a lining material, thus maintaining the external appearance. PE was followed by wax-paper, newspaper and tissue paper as regards their effectiveness for weightloss and external appearance.

3.4. Effect of wax-coatings

In order to study the effect of wax-coatings on the shelf-life extension of mangoes, hard, green mangoes of Samar Bahshit variety were dipped in a wax-emulsion (prepared from Fruitex) of various concentrations. wax-coated and control mangoes were held in boxes lined with newspaper and stored for 2 week at room temperature ranging from 30-35°C. The data collected at subsequent intervals revealed that weight loss of wax-coated mangoes was significantly ($P<0.001$) reduced by waxing and, therefore, waxed mangoes did not shrivel. Both bicochemical and organnleptic parameters of wax coated fruits were normal and ripening was delayed for about one week (26).

3.5. Effect of controlled atmosphere storage

The effect of controlled atmosphere (CA) on the shelf-life extension of many fruits has been established (9). In order to study the effect of N_2 on the shelf-life of mangoes, an experiment was carrried out when hard green mangoes were sealed in a vacum oven in which N_2 gas was flushed. It was noticed that even after 2-week storage the mangoes remined hard and green and did not ripe. When these mangoes were removed to normal air, they turned brown and faild to ripen normally. This means that the level of O_2 in the atmosphere was less than the critical level and this needs to be established.

3.6. Control of storage diseases

The principal storage disease of mangoes are anthracnose and stem-end rot. In order to study the incidence of rot attack and its possible control, 2 experiments on 'Dusehri' mangoes were carried out during 1978-79. The effect of various fungicides like thiabendazole (1000 ppm), Benlate 500 ppm), Captan (2500 ppm) and Antracal 1400 ppm) were tasted. Freshly harvested fruits were dipped separately in aqueous solution of these fungicides for 2 minutes and then dried. The fruits were held in wooden boxes lined with newspaper at room temperarure. No significant effect of these fungicides was noticed on the control of these disseases (5). Therefore, some more experiments were carried out to study the effect of hot water dip alone and in combination with gamma irradiation 30 Kard. Hot water dip (55°C for 5 min.) alone significantly ($P< 0.01$) reduced rot incidence but a significant ($P< 0.001$) synergestic effect was recorded when radiation was used with hot wate treatment. After a 2-week storage the incidence of anthracnose and other rot was fonnd to be 25% in untreated fruits, 30% in hot water treatment and only 10% in combination treatment (unpublished).

4. Acknowledgement

we are thankful to all scientists who have been associated with these studies from time to time. Thanks are also due to Dr. Amin M. Hussain, Head, Food Scienc Division, NIBA, Frisalabad for reviewing the manuscript.

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audience of the seminar.

PLANT FOR COMMERCIAL DEHYDRATION OF FRUITS AND VEGETABLES

By

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INTRODUCTION

Pakistan produces a large quantity of fruits and vegetables, of which a substantial portion is lost either due to lack of transportation to centres of consumption or due to gluting of markets in periods of peak production. Statistical figures available, through the courtesy of Ministry of Agriculture and Food, put the annual production of vegetables around 30 lack tons (averaged for the last 5 years. If only one third of this quantity is taken that goes wasts as against the much quoted 60% for the total agricultural produce, one can easily calculate that 10 lac tons of vegetables worth Rs. 150 to 200 crore are lost every year. This is indeed a colossal loss. which a country like Pakistan cannot afford to sustain.

Fruits and vegetables are seasonal and perishable commodities. Consequently their prices fluctuate between the lowest in qlut periods and the highest during off-sessons. The existing cold storage facility, meant largely for short term preservation is insufficient and certain fruits and vegetables (potatoes, banana for example) cannot be edequately preserved through the use of this facility. perishable foodstuffs may be converted in to stabilized products that can be stored for extended pariod of time by employing techniques such as canning, freezing freeze-drying or hot air drying (dehydration) etc. Out of these techniques, dehydration is considered to be the most simplified and cheapest method for preservation of fruits and vegetables.

Dehydrated fruits and vegetables are most commonly produced by using artificially heated air to take out moisture from the wet material. Various operations involved namely the initial preparation, drying proper and final packing are more or less the same for both fruits and vegetables. Both are washed, peeled, sub—divided, sulphured blanched (not fruits), dried and packed. Onions and garlics are not blanched for reasons of loss of pungency.

Advantages of Dehydration

1. The shelf life of fruits and vegetables is appreciably extended, because the water activity is reduced by dehydration be low that at which micro-organisms and

enzymes are active. Dehydration increases the concentration of sugars and acids creating an environment unfavourable for microbial and chemical degradative processes, the residual moisture being firmly bound and unable to act as mobile carrier for reactants.

2. Both weight and volume are substantially reduced by dehydration, thereby cutting the cost of transport, packaging and subsequent storage.

3. Dehydrated fruits and vegetables are considerably less costly to produce than the equivalent quantities of canned' frozen or preserved material.

4. Dehydrated products do not require refrigerated storage (as do frozen commodities) and in fact they can be stored at ambient temperatures for over a year. The contents of a container can be used some time after opening, provided moisture reabsorption is avoided.

5. Certain dehydrated materials have specialised applications (e.g. dried soupsI and banana flour) for which materials processed otherwise are not suitable.

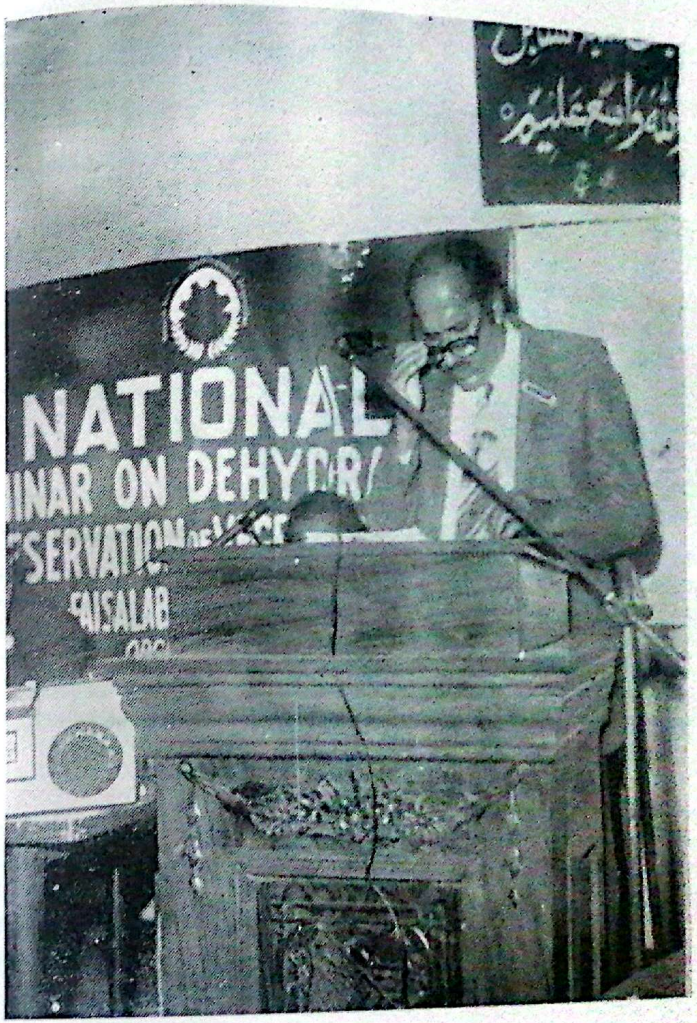
Types of Dehydrators

Several types of dryers are in use for the dehydration of foods, the type depending on the nature of product. Liquit foods like milk, eggs and fruit juices are spray dried. while slurried foods, concentrates and pure are drum-dried. Foam-mat drying is becoming popular these days for producing tomato, egg and fruit juice powders. The costly method of freeze—drying is employed for specialized products

Solid foods like fruits and vegetables may be dried, for example, in a bin dryer, conveyer dryer, cabinet or tunnel dryer. Each type has its merits and demerits. The tunnel dehydrator is by for the most popular machine employed for large scales processing of fruits and vegetables.

A. Tunnel Dehydrator

A typical tunnel dehydrator consists of a long rectangular tunnel with the hot air blowing a long its length. The wet material (normally, the prepared commodity in piece from) is spread on perforsted trays (1 to 4 I be. per sq. ft) and stacked into trolleys usually 4 to 10 in number which are wheeled end to end into the dryer. The temperature can be held steady and the trolleys moved shead every time a new one is inearted. Thus the wet material is conveyed in semi-continuous flow and amerge substantially dry at the opposite end of the tunnel. With this design, it is much easier to obtain uniform air flow as against a cabinet dryer. One or more fans are arranged according to the particular design, although the common procedure is to locate a single fan near one end of the tunnel. The heating equipment may be located to one side, above or below the drying tunnel. The more important arrangements of air flow may be classified as concurrent and counter—current. The



Dr. M. Jamil, presenting his paper.

counter-current tunnels are more efficient and are usually preferred, but these are more difficult to load compared with parallel flow tunnels.

For large scale operations single tunnels of 40 to 60 ft in length have been commonly used in the United States; it is however a common practice to construct several tunnels side by side rather than to increase the size of a single one.

Relative Merits of a Tunnel Dehydrator

1. It is less costly to build and to operate.

2. Its operation can be arranged to be either intermittent or continuous.

3. It permits more uniform drying.

4. It can be arranged to operate as a same or fully automatic machine by timing of a sequence of trolleys and by controlling temperature, humidity and velocity of air.

5. It permits more rapid drying without heat damage to the material. The hot air may be circulated at much higher velocities which result in a proportionate increase in evaporation. In other types, air is forced upward through the material supported on perforated trays which offer a greater resistance to air flow, consequently drying is slow and uneven.

6. The fruits and vegetables may be moved toward a region of higher temperature and low humidity or vice versa depending upon the nature of a particular fruit or vegetable. The equipment is therefore versatile and can be used for drying any other commodity or biological material.

7. Scale up is no problem for larger production. Instead of increasing the size of a single tunnel, a series of similar tunnels operating independently may be constructed.

The Experimental Pilot Unit

In view of the above merits, single-stage tunnel dehydrator measuring 14' × 3' × 4.5' was constructed using brick structure. Four trolleys loaded with prepared vegetables (sliced onions mostly) could be inserted one by one into the tunnel at an interval of 1.5 hours. A fifth trolley was available for loading of fresh meterial. Air heating was achieved through natural gas burning in an ordinary furnace situated by the side of the tunnel. Hot air was blown through the tunnel by means of an axial fan. A part of the spent air (30%) was vented and the balance circulated back to the hot end of the tunnel. The recirculation of humid air is essential to save loss of heat and to avoid case-hardening of the tender material, which if allowed to happen renders the upper surface hard and impervious to the diffusional transfer of moisture from within the wet material. Drying then becomes extremely difficult.

Using the above equipment, both the concurrent and counter-current operations were employed separately for drying studies on vegetables. The dry and the wet bulb temperatures at the hot end were about 80°C and 43°C respectively and at the cold end about 55°C and 40°C. The material dried to about 15 % moisture content in the countercurrent fashion after a residence time of 6 hours, but was of poor quality due to heat scorching. In the con-current operation, the material was of good quality but suqstantially wet (30 %moisture content), which was further dried to about 15 % moisture content by allowing it to stay in the tunnel for few more hours.

In both the concurrent and countercurrent aplications of hot air flow, the material on each trolley was found to be dried unevenly. The material facing the hot end of the tunnel was over dried with signs of heat browining due to direct impact of hot air and that facing the cold end was substantially wet. This point towards the advantage of uniform drying that can be gained by the successive application of concurrent and countercurrent operations or vice versa in a dehydrator.

Removal of moisture below 15% was found to be extremely difficult and the drying material, of necessity, took additional 10-12 hours in the tunnel before its moisture content was below 5%. The quality of material deteriorated excessively during this last stage of probably because of prolonged at elevated temperature. Because of low water diffusion to the surface, high air velocities and temperatures are not needed at this stage. Furthermore, those parts of material not directly exposed to the hot air (underside surfaces) remain wet for pretty long time, while the upper surfaces get over-dried. Shaking of the material becomes a necessity at this stage of drying.

The final stage of dehydration (i.e. below 15%moisture content) was therefore carried out by transferring the material in a combient type finishing dryer operating at 60°C with low air circulation. The transferring of product helped a great deal in equalizing the moisture content before the product was taken out for packing.

Consideration for a Combined Flow Dehydrator

From the forgoing it is clear that there are distinct advantages in using a combination of concurrent and counter-current tunnels over a single stage dryer. The reversal of the direction of movement of material with respect to the air flow would give a uniform treatment to both the front and back side of trays, so that the material would be evenly dried in shorter times giving an inerased output. The use of a finshing dryer in conjuntion with the combined flow dehydrator helps further improving the plant out-put with a better quality product. If a common heating source and fan are used for the two tunnels, a greater degree of economy in heat and air could be achieved.

These conclusions are in accordance with those quoted in the literature and in fact a number of two stage tunnels are being successfully operated in the more advanced countries.

The PCSIR Twin Tunnel Dehydrator

Working on these lines the PCSIR developed a Twin-Tunnel dehydrator of two tonns/day

processing capacity, the being the first of its kind in Pakistan. Over 500 tonnes of various vegetables have been successfully dried and supplied to interested firm for their market survey. Technical details and process know-how have been supplied to 3 local firms of international repute. The PCSIR is rendering assistance in the installation of commercial plants for them.

The essential festures of the PCSIR combined flow dehydrator are shown diagramatically in Fig (1), the description is as follows:

The Twin-Tunnel Unit

The unit consists of two drying tunnels 22 ft. long by 3 ft. wide by 4.5 ft. high (inside diamension) with a central hot air chamber of equivalent length and height and a width of 7 ft. Ordinary brick-structure has been used in the construction. A direct fired furnace and a double entry centrifugal blower are located in the central chamber. Air heating is achieved through natural gas burning. The products of combustion are mixed with the outside air and discharged by the blower into the two drying tunnels. Upon leaving the tunnels, part of the air is recirculated through the cold end side-porrs opening in the central chamber, while the rest is exhausted to the atmosphere via overhead discharge ducts. About 4 ft. of space is left at the hot end of each tunnel for the air to straighten out before entering the trays, after making a smooth turn from the central chamber into the drying tunnels. A set of deflectors and dampers helps in the uniform and even flow of air across the section of both the tunnels. Wooden doors with inside protection by galvenised steel-sheets have been used for the tunnel inlets and outside.

The unit accommodates in each drying tunnel 6 tralley-loads of trays, so that there is 600-700 kg of drying material at any one time the tunnels durings full load operation.

Trays and Trolleys

Very cheap sarkanda-bottom trays of size 2½ ft. by 1-1/4 ft; were fabricated at the PCSIR Laboratories, Lahore. The tray consists of a metallic frame made from galvanized steel band having perforations and a sarkanda network firmly held by the sides. Free space for upward passage of air consists of one third of the total tray areas. The drying material does not stick to the uneven surface and easy to scrope off during de-traying operation at the end of drying cycle. These trays can be easily fabricated and the plant personel can repair the trays during the off-session.

Drying trays are conveyed through the tunnels and to the loading and unloading station on trolleys. The trolley consists of cubical frame made of angle-iron with steel bands fixed to the sides for supporting the trays can stacked on 23 flights of a trolley, each flight having a pair of trays placed side by side. There are 12 trolleys, 6 for each tunnel, and two additional trolleys are available for loading of wet material.

Air Heating System

A standard refrectory brick furnace has been used for achieving direct combustion heating. The furnace is divided into two zones by a checker work for fire brick, the partition helping to break up the flame and favour complete combustion, serving also to confine the radiant heat to the primary zone. The secondary zone helps in the elimination of smoking. The size of the furnace is large enough to serve as a heat reservoir. This together with a large pilot burner helps to keep the temperature fluctuation to a minimum. The flue-gas temperature is usually above 500°C that is too high for the food products, it is therfore diluted with cold fresh air at the furnace together with a part of the spent air from the tunnels.

Hot Air Blower

Ordinarily air velocities of above 300 and not in excess of 1000 ft. per min are used in commerical dehydrators, based on the entire cross-section of the tunnel empty of trays and trolleys. In the presence of trays and trolleys, the lineal velocity across the material will be 50 to 100% greater.

A centrifugal blower consisting of a fan wheal rotating within a scroll shaped housing, is capable of moving air over a wide range of volumes and pressures. It is more efficient and less noisly than an axial fan. A double-entry centrifugal blower with backward inclined wheel blades making them non over-loading, has been used for circulating air in both the tunnels. An axial fan was also incorporated at the exhaust outlet of each tunnel for increasing the air velocity inside the tunnels. The air velocity in the empty tunnels measured by means of an anemometer was around 500 ft/min the air handling capacity of the blower being 20,000 cu. ft. per min.

Instrumentation and Control of Variables

A satisfactory dehydrator should permit close control of temperature, air velocity and relative humidity. Thus dry bulb temperature of air entering the tunnels is automatically controlled by a simple on - off temperature control system. This consists of a thermostatic switch opening and closing an electric solenoid value fitted in the gas supply line. Dial thermometers with long leads are fitted at the hot end cold ends of each tunnel to indicate temperatures at these points. By adjusting the deflectors in the central chamber, it is possible to raise the temperature of hot air entering the concurrent tunnel with a proportionate decrease in temperature of the countercurrent tunnel. The optimum temperature setting for most purposes of fruit and vegetables dehydration is 80°C for both the tunnels. Dial hygrometers are also fitted at each end to indicate the relative humidity of air. About 10% R.H. of the hot dry air is always maintained at the hot end by recirculating a part of wet exhaust air, the rate of flow being controlled by dempers fitted in the recirculation ports. A detailed account of air velocities has been given in the previous section.

Finishihg Dryer

Reference has been made to the use of a finishing dryer as an auxiliary equipment and the advantages have been described in the previous sections.

A cabinet type finishing dryer with inside diamensions of 6 ft. × 3 ft. × 6/2 ft. has been built using brick work. Two independent heat exchangers (fin-type) are fitted at the right and left sides of the cabinet. Fin plates are heated by burning natural gas and using products of combustion which pass through toe pipe assembly of the heat exchangers. An axial fan fitted above the RHS heat exchanger draws fresh air from the inlet port situated under the LHS heat exchanger, circulates the hot air over the material in the drying chamber and a part is continuously exhausted to the atmosphers from the rear of the fan via an outlet port in the ceiling. The temperature of the finishing dryer is automatically controlled by a regulator which is normally set at 60°C.

Partially dried material with about 15% moisture content received from the twin tunnel dehydrator is detrayed and reloaded on two trollays of the finishing dryer. Ordinarily the material of 6 tunnel trolleys can be accommodated on each trolley of the finishing dryer. Both the trolleys containing partly dried material are packed side by side in the finishing dryer and the door closed. The material is allowed to stay in the dryer for over 8 hours after which period it usually dry with about 4% moisture content and is taken out for packaging. The specified final moisture level for most fruits is 24%.

Packing and stotage

Ideally all dehydrated fruits and vegetables should be packed in hermetically sealed cans of tin plate to avoid oxidative changes and moisture penetration which can impair the quality of the product. Usually nitrogen is used for packing dehydrated products especially those which are subject to oxidative changes. Vacuum—packing is also used for certain fruits and vegetables. Polyethylene as a packing meterial in conjunction with cartons has gained importance over the past faw vears becaues of its cheap cost. But polyethylens is not altogether prone to moisture diffusion.

A satisfactory way developed for packing the dehydrated vegetables (powers in particular is) by putting them in polyethylene bags which are heat-sealed to give an airtight closure. These bags are in turn put in large tin cans together with a desiccant material (lime or silica gel) with preferential moisture absorption characteristics. A certain amount of fumigation material (methyl bromide etc.) is also incorporated in the can by a suitable technique to kill insects at all stages of development, including the age. It does not effect the flavor, colour and texture of the product. The tine are finally colder-sealed.

Dehyderated fruits and vegetables should be stored under carefully controlled conditions of temperature and humidity. Temperatures below 20°C and relative humidity below 40% are preferred for satisfectary storage. For storage for longer length of time, hermetically sealed cans must be used.

Preparatory Operations Prior to Dehydration

In order to obtain a dehydrated product of superior quality, the raw material must be harvested and handled properly. Fruits and vegetables are given certain types of preterstment for better storage stability, flavour retention and nutritive qualities. Prior to dehydration, fruits and vegetables are sorted, washed, pealed, trimmed, sliced or dried or dried, blanched (except onions, garlics and cut fruits) and sulphured.

1. Harvesting

Fruits and vegetables must be harvested at the ideal stage for eating and then handled and processed carefully and rapidly. Certain fruits are harvested when still green and are allowed to ripen in storage. Amongst vegetables, tomatoes, peas and leafy vegetables deteriorate repidly after harvesting and should be delivered to the plant and processed as rapidly as possible.

2. Sorting

Fruits and vegetables are carefully sorted to remove rots and blemished portions together with any foreign matter. Sorting is carried out by hand on tables or broad belts.

3. Washing

All fruits and vegetables must be thoroughly washed remove dirt and insecticides. Leafy vegetables are washed by dipping in a tank of water using wire-baskets, the water being continously replamished. Special care is taken to remove adhering dirt from the root vegetables, which may be soak-loosened and then spray-washed in a standard rotary washer.

4. Peeling

Most fruits and root vegetables are peeled using abrasive or mechenical knife peelers, while some (onions for example) are still hand peeled. Lye-peeling machines using 2% solution of sodium hydroxide are used for fruit vegetables that are easily lye-peeled (peaches etc.). For carrots and potatoes. 10 to 15 % solution depending on the variety and maturity of the commodity is used. The temperature of the lye-solution is maintained near the boiling point. At the end of operation, lye is water washed followed by dipping in oilute HCI solution. Garlic peel is blown off after dehydration using a modified from of a standard thresher.

5. Trimming

Ususally the peeled fruits and vegetables carry some unpeeled parts or portions of the calyx, which are hand removed using sharp knives.

6. Slicing and-Sub-Division

Leafy vegetables are usually hand cut or chopped using mechanical cutters, while root vegetables are sliced or diced using automatic machines. The usual slice thickness is 1/8'' to 1/4'' and dice size is ½'' cube. Garlics are randomly chooped in a food cuttar. Cabbage and couliflower are out into shredds. Amongst fruits, grapes, berries, cherries and apricots are dried whole, although the latter may be halved and pitted. Peers and peaches are also halved, pitted and calyx removed. Apples are cored and sliced.

7. Blanching

With the exception of onions and garlics, all vegetables commonly dehydrated are blanched prior to dehydration. Blanching is an operation in which foods are heated for a few minutes at or near boiling temperatures, using either live steam or hot water. Generally steam is preferred to water because of lower leaching losses and greater cleanliness. Advantages of blanching are:-

1. Undesirable enzymes are destroyed.
2. Microbial load is reduced.
3. Air from the tissuse is expulsed and the oxidative deterioration is thus lowered.
4. Drying times are markedly reduced.
5. Reconstitution of dehydrated food is better i. e. the rehydrated product is less tough.
6. Vitamins (carotens and ascorbic acid) are better retained on storage.
7. Colour of certain vegetables is better fixed.

The blanching periods are arranged to be sufficient to inactivates peroxidese enzyme in vegetables except cabbage in which catalase and not peroxidase is destroyed in blanching. For most practical purposes, blanching periods ranging from 2 to 7 minutes depending on the type and variety of vegetable are used.

Cut Fruits like apples, apricots and peaches are not blanched because of the resultant softening and

bleeding.

From the blancher, the vegetables are received on trays where they are apread to give a uniform tray load. The material may need cooling (by a cold air blast) to enable hand-spreading wherever required. Potatoes are cooled with water sprays as it also washes away the excess starch in the presence of which the strips are likely to stick together.

8. **Sulphuring and Sulphiting**

Cut fruits are exposed to the fumes or buring or dipped in bisulphite solution before drying. Sulphuring inactivates enzymes and acts as antioxidant preventing discoloration of the product during storage. It helps in bleaching the surface of fruit that has become brown by exposure and prevents further browing and as a result sulphured products are translucent.

Stripped, diced or otherwise cut vegetables are dipped in, or sprayed with solutions of dilute sulphits or bisulphits or both, to retard oxidative changes in storage. Sulphiting also protects the vegetables aganist scorching-damage during dehydration and higher than usual temperatures can be applied to the sulphited vegetables. Onions have a longer storage life if sulphited, but their pungency is reduced. Peas, having their value as a source of thiamine which is destroyed by sulphiting, are not treated with sulphur.

Certain fruits (resisine for example) and vegetables (e. g. bitter gourd) are not given sulphur treatment as it bleaches their colour.

9. **Traying**

Fruits and vegetables after coming out of preparatory operations are spread on trays, usual tray load being from about 1 to 2 lbs per sq. ft. Light and even loading is important for better quality product. Heavy and uueven loading results in a slow and uneven drying with large lumps of material remaining wet for long times.

The sarkands-bottom trays used in the PCSIR Twin-Tunnel Dehydrator have an area of 2 sq. ft. Tray loadings of 1/2 to 2 Kilos are usually used.

The loaded trays are stacked on trolleys, which are passed turn by turn through the dehydrator.

Operation of Dehydrator for a Typical Run

Trolleys loaded with the prepared material are passed one after the other through hot air draft in the Twin-Tunnel Dehydrator. The hot end temperature of both the tunnels is fixed at 80°C.

Trolleys first move against the hot air draft in the countercurrent tunnel and then parallel with the hot air draft in the countercurrent tunnel. During full-load operation. there are 12 trolleys in the dehydrator 6 in each tunnel; at any one time.

Under conditions of continuous dehydration each trolley loaded with drying material enters the exhaust end of the countercurrent tunnel after an interval of 30 minutes and at the same time a countercurrent treated trolly is uithdrawn from the hot end of the same tunnel. This is now pushed into the concurrant tunnel at the hot end in a manner that the back of the trolley now faces the hot air draft. Simultaneous with this entry, a party dried trolley—load of material is withdrawn from the hot end at the same tunnel. This is now pushed into the concurrent tunnel at the hot end in a manner that the back of the trolley now faces the hot air draft. The operation of introducing and withdrawing the trolleys is performad as quickly as possible to minimise heat losses. As a matter of fact, a greater degree of heat economy was achieved by introducing and withdrawing pairs of trolleys with less frequent opening of doors of the two tunnel, using an interval of one hour instead of ½ hour.

If the dehydrator is not to be run continously for 24 hours, then the starting and ending of dehydration requires some careful manipulation with respect to temperature and movement of trolleys, so that each trolley-load receives identical treatment and is dried to required level.

The material received from the concurrent tunnel contains 15 to 20% moisture which is removed in finishing dryer operation at a temperature of 55 - 60%°C. The partly dried material of 4 trays is transfered to one tray end loaded on the trolley for the finishing dryer. The material of 12 tunnel trolleys can be transferred to 2 trolleys of the finishing dryer.

The moisture content of the material after residence of over 8 hours in the finishing dryer falls 5% which is taken out for packaging.

Dehydrated garlics contian paper-husk which is removed by passing through a modified thresher and the kernals so obtained are ground to a fine powder. In the process of grinding, garlic powder being hygroscopic, reabsorbs moisture which is eliminated again in the finishing dryer before packing.

Processing Various Vegetables

Large scale processing of 9 different vegetables has been carried out using the above equipment. The dehydration ratio of each vegetables together with the processing cost per kilo dehydrated product (excluding the raw material and packing costs) is given in the following table:

Name of Vegetables	Dehydration Ratio	Processing Cost Per Kilo dehydrated product
Garlic	5 : 1	Rs. 6.55
Onion	11 : 1	12. 16
Tomatoes	24 : 1	29.29
Green peas	30 : 1	30. 50
Okra	12 : 1	13.54
Potatoes	6 : 1	6.34
Turnips	15 : 1	14.81
Carrots	16 : 1	15.97
Spinach	25 : 1	24.21

It will be seen that in general the processing cost of each vegetables is around Rs. 1.00 pe (excluding weight losses). Since about 5 kg. dehydrated product (except powders) can be packed in ra case of 4 gallons capacity costing Rs 5.00' packing cost per kg dry product would be nearly Re. 1.00. So that the total production cost for each vegetables can be worked out by adding processing cost of Re 1.00 plus the prevailing cost of raw material in the processing cost of each vegetable under the last column. Since the raw material cost contributes a great deal in determining the cost of production, there are, therefore, distinct advantages in processing each vegetables when it is available at the lowest possible price.

Quality Aspects

Storage tests on the quality and shelf life of the dehydrated products have also been performed. The results can be summerised as follows:—

Total bacterial count did not exceed 60,000. Residul sulphurdioxde content was less than 500 ppm which reduced to below 300 ppm after several months, storage. It was observed that ascuobic acid suffered a loss of about 20 % during dehydration of vegetable. Storage studies of up to 12 months were carried out and the product was found to be equally good colour, flavour texture and reconstitution (rehydration) properties.

Plant Capacity and Investment

The Twin-tunnel dehydrator has a processing capacity of 2 tonnes fresh vegetable per 24 hours continuos run. Thermal efficiency of the dehydrator is about 44%. Skilled and non-skilled labour requirement is 6.

The plant can be installed at a total cost of Rs. 15 lac (excluding the cost of land and utilities e.g. power, water, sewer and transport which supposed to be available at plant site). The break up of total investment is as follows :-

		Cost in Rupees
1.	Cost or equipment and machinery	6.0 lac
2,	Cost of building	4.5
3.	Working Capital	4.0

It may be added that the plant capacity can be easily doubled by an additional expenditure of Rs. 5 lac by simply installing another set of Twin-tunnel. Total land area required would be 2 kanals.

The PCSIR has published a feasibility report on commercial dehydration of vegetables giving detailed account of prospects and potentials establishing this industry in the country.

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DEHYDRATION AND PRESERVATION OF FRUITS AND VEGETABLES IN SIND

by

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Introduction

Pakistan is one of the fortunate countries where Allah has given all types of soils and a variety of climatic conditions conducive to the growth of various kinds of fruits and vegetables in abundance. The present economic policy of Pakistan is also giving more emphasis on the Agricultural development to increase the Agricultural production so as to meet the demands of the country as well as to earn foreign exchange by exporting the Agricultural Commodities.

The area and production of fruits and vegetables in Pakistan for the year 1977-78 is as under:-

	Area in Hectares	Production in Tons.
FRUITS	273000	2348400
VEGETABLES	I47900	175400

A substantial part of the total production of our fruits and vegetables (i.e. 20% - 30%) is lost on account of wastage during picking, packing, transportation and storage. Though we need more fruits and vegetables to be self sufficient it is painful to note that we are not deriving full benefit even from what we are producing. These losses can be minimized by processing and preservation of fruits and vegetables. Under the existing circumstances the processing and preservation of fruits and vegetables has assumed a great economic importance in our developing economy. In fact, Horticultural Industry can not make any commendable progress in the absence of a sound processing and preservation industry.

It was therefore felt that establishment of a Fruit preservation and processing research section was essential to findout suitable methods of presservation of fruits and vegetables.

The research work conducted on preservation of fruits and vegetables in the newly created Food Technology section at Sind Horticulture Institute, Mirpurkhas since 1964-65 is briefly given as under:-

FRUITS

1.
BLOCK
1. Saline and Salination of raw mango slices
TREATMENTS

A) Salting
1. Dry Salting
2. Salting in Salt solution

B) Solution (6%)
1. Salt solution (6%)
2. 6 % Lye solution
3. 6.5% Sodium metabisulphite solution
4. Sulphur fuming Exactly
5. Lye + Sulphur fumed
6. Sodium metabisulphite + Sulphur fuming
7. Lye solution + Sulphur fuming

The slices are salted raw mangoes were washed, cleaned and sliced. The slices were kept in the respective solutions.

The slices were kept in solution in the above solutions for 3 hrs as fresh fruit takes but the sliced fruit were kept for good time to drain off the excess solutions and the slices which were to be sulphur fumed were kept in a closed chamber for sulphur fuming, for 1 hr 1 min the sulphur the slices were spread in cardo layers on trays and kept in dehydrator at a temperature to dry.

The fruit not sulphured slices were put into polyethylene bag trays and were dried in sun dry yard. The observations were recorded for their colour, texture and taste at an every two weeks. The results obtained that raw mango slices treated with Sodium metabisulphite + sulphur fumigation were to dry in dehydrator, gave better product than the others.

2. Packaging Materials

The following packaging materials were selected for packing purposes.

1. Cartons
2. Printing Polythene
3. Covers

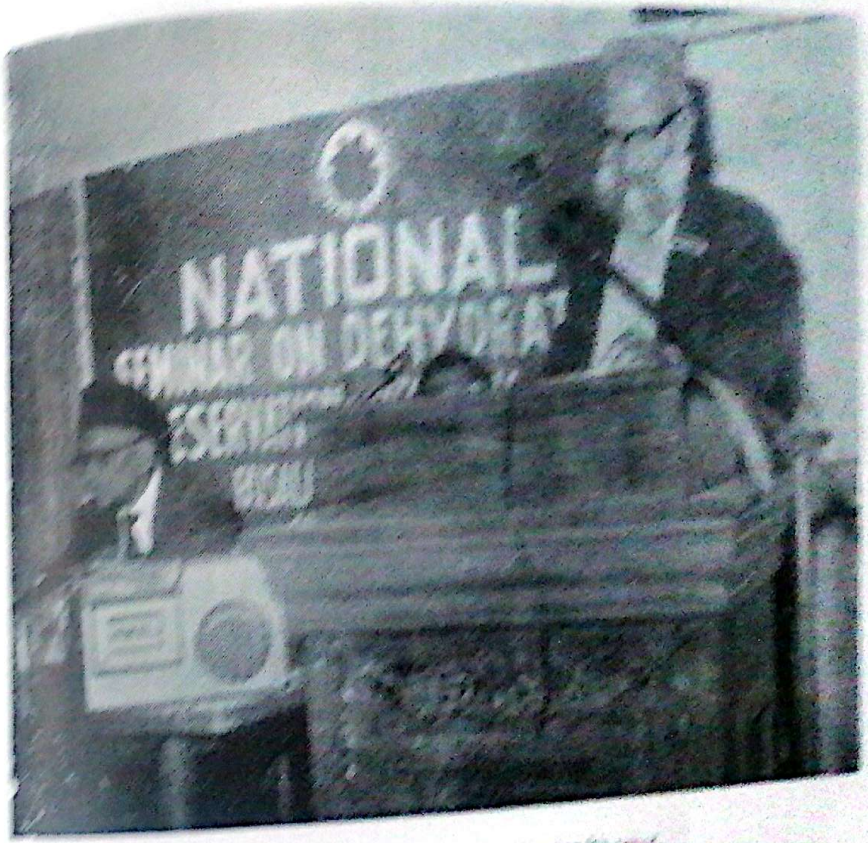

Fig. 1 Shelf of Fabricator, processing the juice.

FRUITS

MANGO

1. Drying and dehydration of raw mango slices

TREATMENT

A) Drying

1. Sun Drying
2. Drying in dehydrator.

B) Solution (0.5%)

1. Sun solution (0.5%)
2. 0.5% Lye solution
3. 0.5% Sodium metabisulphite
4. Sulphur fuming directly
5. Salt + Sulphur fumed
6. Sodium metabisulphite
7. Lye solution + Sulphur

The mango slices

in the square shapes

The slices were

treated slices were

treated with sulphur

After fumigation

slices were

2.

Bagenpali

Swarnarika

ome ripe mangoes were washed peeled and sliced longitudinally. The slices were put
sterilized cans and the boiling syrups of the required boiling degrees (20 - 30 per cent)
d in the cans and the cans were sealed for each pair but for one pair the slices were put
required syrup were kept in the boiling water for two to three minutes and then sealed.

The sealed cans were then put into boiling water for 20-30 minutes for sterilization and the
into cool running water for immediate cooling.

The observations were recorded after every three months to flavour, taste, consistency and
ge shown. The results obtained indicated that Bombay Alphanso proved to be a better
canning purposes as it gave best products at 25° and 30° boiling irrespective of the sulphur
s stored for twelve months. Sindhari variety proved to be next best at 25° boiling and un-
ulphured for the same period followed by Langra and Swarnarika varieties while
Totapuri variety was not suitable at all for canning.

ling of Mango Juice.

The following Mango varieties were selected for bottling of juices of ripe mangoes

TREATMENTS

A. Varieties.

1. **Seedling Mangoes.**
2. **Sindhri.**
3. **Bombay Alphanso.**
4. **Khasa.**
5. **Pagenpali.**
6. **Swarnarika.**
7. **Langra.**
8. **Sirohi.**

B. Method of preservation.

1. **Adding Potassium metabisulphite.**
2. **Adding Suggar Potassium metabisulphite.**
3. **Pasteurization.**

Healthyfully ripe mangoes of the above varieties were washed, cleaned, and juice was
ted and strained through pulping machine. The juice of the individual variety was preserved

4. Baganpali

5. Swarnarika

Some ripe mangoes were washed peeled and sliced longitudinally. The slices were put into cleaned sterilized cans and the boiling syrup of the required boiling degrees (20°, 25° and 30°) was poured in the cans and the cans were sealed for cold pack but for hot pack the cans with slices containing required syrup were kept in the boiling water for two to three minutes and then sealed.

The sealed cans were then put into boiling water for 25-30 minutes for sterilization and then plunged into cool running water for immediate cooling.

The observations were recorded after every three months on flavour, taste, consistancy and colour of the slices. The results obtained indicated that Bombay Alphanso proved to be a better variety for canning purposes as it gave best produce at 25° and 30° boiling irrespective of hot and cold pack when stored for twelve months. Sindhri variety proved to be next best at 20° boiling cold and hot pack when stored for the same period followed by Langra and Swarnarika varieties while Baganpali variety was not suitable at all for canning.

3 **Bottling of Mango Juice.**

The following Mango varieties were selected for bottling of juices of ripe mangoes.

TREATMENTS

A. Varieties.

1. Seedling Mangoes.
2. Sindhri.
3. Bombay Alphanso.
4. Khasa.
5. Baganpali.
6. Swarnarika.
7. Langra.
8. Siroli.

B. Method of preservation.

1. Adding Potassium metabisulphite.
2. Adding Suggar Potassium metabisulphite.
3. Pasteurization.

Healthy fully ripe mangoes of the above varieties were washed, cleaned, and juice was extracted and strained through pulping machine. The juice of the individual variety was preserved

with the addition of Potassium metabisulphite at the rate of 0.62 gms per kg of pulp and [illegible] the rate of 100 gms per kg and the pulp was bottled as shown above. The pulp was tasted after [illegible] three month storage for colour, flavour, taste, consistancy, sweetness and acidity.

The result obtained revealed that seedling mangoes, Sindhri, Bombay Alphanso and Kesar gave better colour, taste and flavour than other varieties, when preserved with the addition of sugar and potassium metabisulphite, while varieties like Langra and siroli were next best. The pulp could be stored up to 24 month even, at ordinary room temperature.

4. DATES

The following Dates varieties were harvested at Dung stage for Katal, Adiya and Khajur preparations and at Doka stage for Chohara preparations.

Varieties.

1. Asuli.
2. Fasli,
3. Idalshahi.
4. Shakri.

The Dates were separated from the bunches, washesd, cleaned and prepared for curing. The dates were spread in single layers on trays and kept in curing chambers at temperature from 120-130 F. The cured dates were put into Polyethypene film bags and stored at ordinary room temperatures. After every three months storage, samples from each lot were taken and tasted for their colour taste and texture. The results obtained revealed that Idalshahi variety proved to be better for Katal preparation, while Shakri and Asuli are better for Chohara and Adiya preparation.

5. NECTARS.

Guava, nectar, Papaya nectar were prepared on commercial lines. Guava nectar proved to be very successful. It was liked very much and was in great demand in the markets.

6. JUICES

Jaman juice, Mango juice and Lime juice were also prepared and bottled. And there is great demand for them. Jaman juice is also in great demand mostly by people who are diabetic.

7. CANDIES

Amla and Ber candies were prepared including their preserves.

II. VEGETABLE

DEHYDRATED POTATOES

Potato is a good source of carbohydrates. It is a perishable vegetable and can not be stored

at room temperatures for long during summer. Cold storage facilities are meagre and thus many losses are recorded due to high temperatures.

To save these losses work on dehydration was taken in hand.

TREATMENTS

A. *Preservative*	B. *Blanching*
i. Potassium metabisulphite 0.5% solution.	i. 5 minutes.
ii. Sodium Benoate. 0.5% Solution.	ii. 7 minutes.
iii. Tye solution. 0.5% Solution.	iii. 10 minutes.
iv. Salt solution ,, ,,	

Fully matured healthy potatoes were washed, cleaned, peeled, sliced and were put in 0.5 solution of preservatives for 20 minutes. Then the slices were rinsed with ordinary tap water and blanched in boiling water for 5, 7 and 10 minutes as the case may be and spread in single layers on the trays and kept for dehydration. The temperature of dehydration was maintained at 160 °F-180 °F for first two to three hours and then reduced to 120-150 °F till the slices are fully dried.

The dried slices were put into polythelene film bags, sealed and stored at room temperatures and tasted after every three months storage for colour, taste and texture. The data revealed that the potato slices blanched for five to seven minutes after treating them with 0.5% solution of potassium metabisulphite gave better results than the others, followed by the slices treated in salt solution.

2. DEHYDRATED PEAS

Peas are rich source of proteins. These are liked by every one in the green stage than dried because of the taste. Peas can not be kept for long in the green tender form. In foreign countries these are canned but in our country these are not canned on a large scale because of high cost of containers and in adequate facilities of canning. However the preservation by dehydration would play a good role in making them available through out the year.

TREATMENTS

A. *Solution*	B. *Blanching*
i. 2% salt.	i. 5 minutes.
ii. 4% salt.	ii. 10 minutes.
iii. Tape water.	iii. No blanching.

Green fully matured pods of Blue Bantum and Early dwarf peas were taken and the seed were separated from the shell. Peas of each variety were blanched in 2% and 4% salt solutions for 5 to 10 minutes, and some lots were blanched in ordinary tap water. The others were kept without blanching. They were then dehydrated in a dehydrator at a temperature of 130-140 F°.

The dehydrated peas were put into polythylene film bags sealed and stored at room temperatures. After every three months storage the samples from each variety were tasted for colour, taste and flavour. It was found that green peas blanched in 2% salt solution for five minutes gave better colour, taste and flavour than the other samples.

In addition to this Brinjals, Carrots, Gourds, Okra, Cauliflowers, spinach, were dehydrated and were safely stored at room temperature in good condition.

Tomato juice, Tomato Jam and Tomato Ketchup were also prepared on commercial lines and proved very successful. These products were of good quality.

CONCLUSION

The research findings will prove of great benifit if put on commercial scale. There is great need of establishing the Canneries in the area where fruits and Vegetables are grown in bulk.

The research work whatever possible was conducted depending on the availability of staff and the funds. The work is being continued on similar lines on other fruits also and the results will be made available in due course of time.

Though we are not self sufficient in fruits and vegetable production but yet we need to preserve them just to save the wastages and it can be minimized by following the scientific methods while Picking, Packing, Transportation, Storing at their appropriate temperatures in cold storages, depending upon their qualities and characteristics, and can be made available for a quite suitable time. As fruits and vegetables are perishable commodities in their nature, hence some of them are spoiled within a short duration while others take more time. It therefore becomes necessary to save the fruits and vegetables either by canning, bottling or by dehydration for long storage to ful-fil the country requirements in off seasons as well as for export. Due to economical factors, the canning becomes expensive because of high cost of raw materials and processing charges than dehydration. Jams, Jellies, Pickles, Juices and Squashes can easily be prepared and preserved in bottles, and Jars, which may be of glass made or plastic which ever is economical, may be used.

Dehydration of vegetables is easier and economical than fruits and can be adopted on small scale as well as on big scale for local consumption and for export. Dried fruits and vegetables can be stored for long and occupy less space and their weight is reduced to a large extent. In the end I may point out that it is not the final what I spoken but it is a contineous work and there may be new problems for which new methods are to be evolved for the betterment of human beings.

Pakistan Zind-Abad.

STUDIES ON DEHYDRATION OF VEGETABLES

by

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A variety of vegetables are grown in Pakistan throughout the year. But being perishable in nature, a good proportion is wasted during peak season. Preservation of the vegetables by one or the other way could help in controlling this wastage. Pakistan, being a developing country with a very low per capita income, cannot afford to go in for costly means of preservation. The best method of preserving vegetables, for the Common man, is to dry these Vegetables during the peak season.

No special equipment is needed. Dried vegetables will occupy only one fifth the space required by fresh vegetables and it can be stored in polyethlen bags.

The main advantages of dehydrated vegetables are that these are easy to store, being lighter in weight and lesser in bulk than fresh or other processd vegetables; these do not require refrigerated storage as do frozen foods and above all the contents of a container can be used some time after opening, provided they are not reconstituted.

The main disadvantages are that the dehydrated vegetables are unattractive in dry state because they are brittle and often less colourful than fresh vegetables. The dehydrated vegetable take longer reconstitution before cooking.

Dehydration accomplishes preservation of foods by removing water and creating a chemical environment unfavourable to the growth of many microrganisms and enzyme activities,

The unit operations involved in the dehydration of vegetables are washing, peeling, trimming shredding, blanching, (except onion and garlic). Sulphiting, drying and packing.

i) Quality of Vegetables

Vegetable used for dehydration should be proper maturity and of good cooking quality.

Immature vegetables do not have proper colour and flavour where mature ones are often tough and woody.

ii) Preparation of Vegetables

Preparation varies according to the type of vegetable and includes washing, peeling, trimming coring followed by slicing or shredding.

Careful washing is necessary to remove dust, dirt and toxic spray residues and to reduce bacterial load. Root vegetables are cut into slices $\frac{1}{8}$" to $\frac{1}{2}$" thickness.

iii) Blanching

All vegetables except onions and garlic require proper blanching. Its purpose is the inactivations of those enzyme' which cause discolouration of the product and facilites in removal of water from the cells which reduces the drying time by upto 30 percent.

Blaching of vegetables is carried out in steam or water. Blanching in water tends to remove water soluble salts and vitamin and for this reason steam blanching is more desirable. The blanching time requires careful regulation. Underablanching does not give the desired results, which over blanching gives a mashy product which is difficult to dry. The length of time depends on the nature of vegetable, its stage of maturity and state of subdivision. No exact time can be given for blanching the various vegetables but this ranges from 3-8 minutes.

iv) Tray Loading

The vegetables require even spreading immediately after blanching. It has been found that $\frac{1}{2}$ to $1\frac{1}{2}$ lbs per sq. foot is the best tray load.

v) Drying

Dehydrated vegetables are produced by several processes; the most widely uses being hot air process; although freeze drying and puffing processes have been used increasingly in recent years. The conventional hot air drying proces utilizes a stream of hot air passing over and through the layer of vegetable pieces. The temperature and relative humidity of the drying are should be carefully controlled as the optimum point for each is determined by the compromise between the opposing requirement.

vi) Packing

All dehydrated vegetables are packed in moisture proof containers. Dehydrated vegetables Proper packing coupled with thoroughly applied fumigation protects the dried food. Fumigation kills all insects in all stage of development including eggs. Ethyl or met formate and propylene oxide added before sealing and packaging are very effective in providing protection against insect infestation.

1: Dehydration of Bittergourds

Bittergourds were peeled, out into halves and cored for over mature seeds. Preparatory losses were 26 percent. The prepared material was blanched in boiling water for 7-8 minutes. Sulphiting of the vegetable was carried out by immersing the blanched material in 0.5 per cent potassium metabisulpite solution for 15 minutes.

The prepared bitter gourds were spread on the dehydration trays @ 1.0 - 1.5 lbs per sq. foot and kept in the cabinet dehypration. It took 6-8 hours to dehydrator the bittergounds to 4 percent moisture contents at initial temperature of 55°C. On unprepared and prepared basis the drying ratios worked out to be 25:1 and 12:1 respectively.

2: Dehydration of Garlic

The individul cloves were separated by hand and the defective ones were removed. The cloves were then cut in to small pieces with stainless steel knives and spread on the dehydration trays @ 1.5-2.0 lbs. per sq. foot. The drying was carried out in cabinet type dehydrator at initial temperature of 66°C and finishing temperature of 55°C. It took 7 took hours to dehydrate the garlic cloves to less than 4 percent moisture contents. The drying ratio on whole and prepared basis was worked out to be 5 : 1 and 4 : 1 respectively. The dried product was ground to powder from and packed in polyethylene bags.

3: Dehydration of Layd's Finger

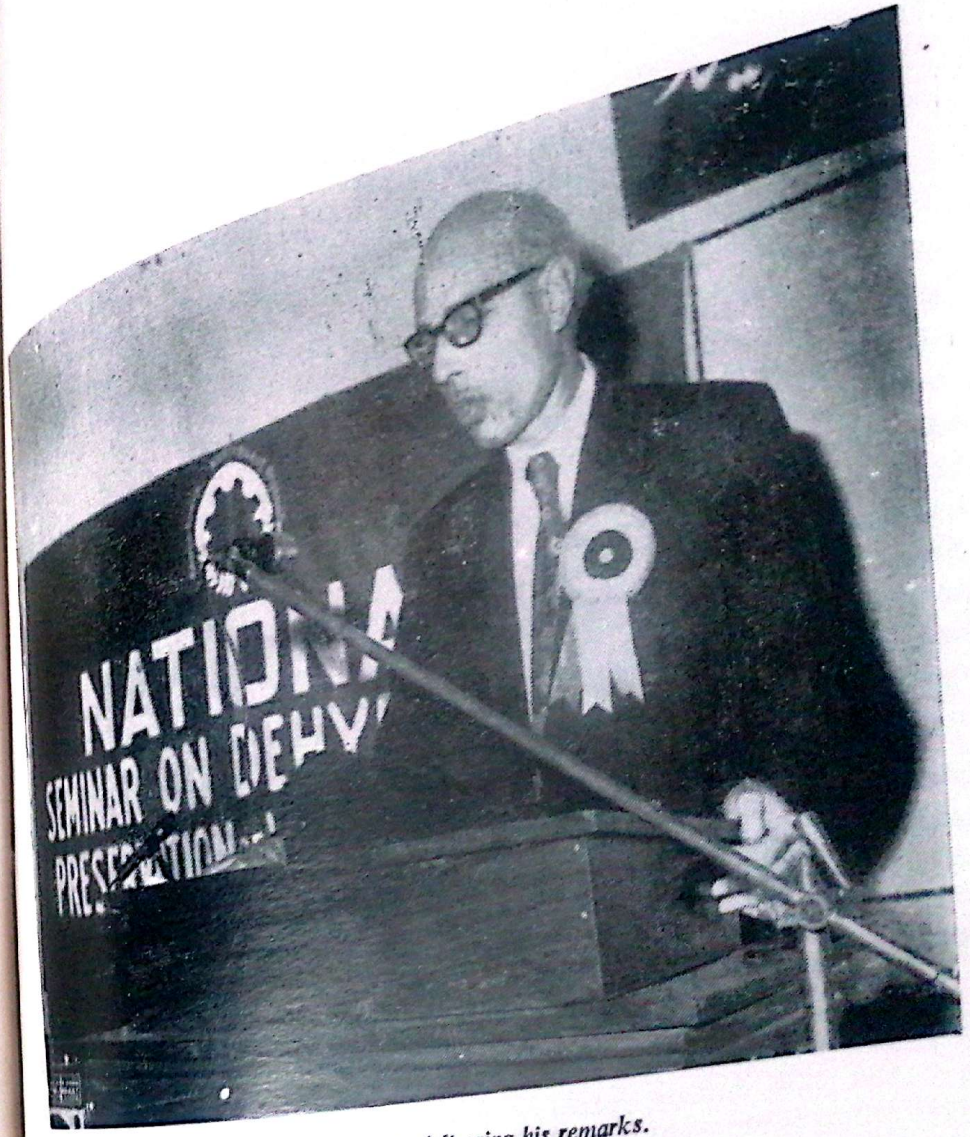
Lady's fingers were properly washed. After removing stalks and tips, those were cut into circular pieces. The prepared vegetable was blanched in boiling water for 2-3 minutes. Blanching was followed by rinsing with cold water to remove mucilagenious coating formed during blanching. The sulphiting of the vegetable was also carried out by dipping in 0.5 per cent potassium metabisulphite solution for 10-15 minutes. The Sulphite vegetable was drained and spread on dehydration teys @ 1.0 to 1.5 lbs. per sq. foot and kept in the cabinet dehydrator. Dehydration was carried out using an initial temperture of 60°C and finishing temperature of 60°C. It took 8-9 hours to dehydrate the vegatable to 4 percent moisture content. The dehydration ratios worked on unprepared and prepared material basis came to be 11 : 1 and 8 ; 1 respectively.

Dehydration of Potatoes

Potatoes were hand peeled and cut into 1/4" to 1/2" thick slices. The prepared slices were blanched in boiling water for 3-5 minutes and then immediately cooled in running cold water. The prepared material was spread on dehydration trays @ 1.5 to 2.0 lbs. per sq. foot and kept in cabinet dehydration. It took 8-6 hours to dehydrate the potato to 4 percent moisture contents at initial temperature of 60°C and finishing temperature of 55°C. The drying ratios on whole and prepared basis were worked out to be 7 : 1 and 5 : 1 respectively.

5: Dehydration of Sarsown sag

Sarswon sag required through sorting and washing. Hard and yellow leaves were removed. The sag was cut in to almost uniform small pieces and blanched for 5 minutes in boiling water. The material was immediatly cooled and spread on the dehydration trays in deep layers @ 0.7 to 1.0 lbs. per sq. foot. The dehdration of the sag was carried out in cabinet dehydrator at initial temperature of 60°C and finishing temperature of 55°C. The leaves dried very rapidly but stem portion due to their greater thickness took longer time to dehydrate to 4 percent moisture contents. It took 8-9 hours to dehydrate the sag and dyring ratio came ont 8.1.



Dr. M. D. Shami, delivering his remarks.

POTENTIAL AND NEED FOR DEHYDRATION OF FRUITS AND VEGETABLES

By

M. JAMEEL MEHAR,

ATDO., ISLAMABAD

roduction

Due to the climatic condition Pakistan is best suited for the growth of vegetables and fruits. It occupies a good position among the countries, which produce a great variety of these commodities in abundance throughout the year. (The area and production-wise break-up of vegetables and fruits is in tables 1-4). Being readily perishable commodities, a substantial portion of this, much needed, food is spoiled before reaching the consumers, for a number of reasons. Out of total grown vegetables and fruits, approximately the losses range from 25-30% during the peak season. Besides, the market becomes glutted with fruits and vegetables. As a result of this the prices of these commodities drop down considerably and spoilage of this important nutritional component also takes place during this period. The variations of the prices were observes in the ratio of 1:10 at Faisalabad market on the average fresh vegetables (table 5). In orders to minimize losses, and stablize prices, it is desirable that suitable techniques should be adopted to prolong the storage capability of such surplus vegetables and fruits.

In the advanced countries, mechanized processes are practised to preserve these commodities for the use of human being, at fairly reasonable prices. The situation, however, in the developing countries is entirely different, where such system of preservations are restricted to only few products. Moreover, the high prices of the finished products are beyond the reach of the masses. Under these circumstances dehydration offers an economical and satisfactory solution to avoid the spoilage by extending their shelf life.

There is thus a great need for simple and low cost approaches to food and crop conservation which should be appropriate to the circumstances, need and currently available skills level, to get benefit from these te)hniques. In theis regard, the use of simple convection ventilated solar dryer seem to offer an apporopistion solution.

Solar Dehydration

Open sun drying has used in many countries since a long time. However the finished prodcts obtained by this system of drving are of poor quality as far as colour and dust-pollution is concerned.

When aiming at a good quality product, tradition sun drying methods require wide improvements, careful operation and full attention to individual processing details.

Necessary Details for Solar Dehydration

Selection, Trimming and Cutting :-

Poor quality crops cannot be processed into products of a high standard. Therefore that material to be dried must be of a good quality, freshly harvested and as ripe as when destined to direct consumption.

After trimming, fruits and vegetables are to be cut into even sized slices of less then 7 mm. thickness, with sharp stainless knife or hand slicer.

Blanching :

The prepared vegetables then are subjected to blanching. Because all plant materials contain active chemical constituents known as Enzymes, which cause undesirable changes in the post-harvested plant materials, particularly in the moist and warm conditions. In the early stages of draying, the condition suitable for enzymetic activity prevails. It is therefore, necessary to subject the plant material to the boiling water to destroy these Enzymes before subjecting to the drying.

If the planching is done by immerssion in the boiling water, this will tend to soak-out some nutrients from the material being blanched. To minimise these lossess, so far as vegetables are concerned, the amount of water is kept to a minimum and same water is used for all the material being blanched at one time.

Blanching of potatoes and other starchy vegetables are exceptional of this rule. In their cases, the concentration of strach in the blanching water is undesirable. Since coating of gelatinous starch is likely to hinder the drying process.

Sulphiting :

Although sulphiting is not absolutely essential it is some time desirable to treat blanched material with a preservative before druing. Since such treatment improves the colour of the product for a longer period.

ATDO's Experiences :-

Initially, the work was assigned to some local R & D Organisations to develop suitable design of dehydrator which may be simple enough to be operated by villagers and mostly uses solar energy. In the meantime, this Organisation procured design and technical know-how, on the solar dehydrators through the courtesy of UNICEF. These designs are simple, easy in operation and can be constructed from mud/bricks, bamboo pipes as cover or pipes made out of used tin (with holes) and polythene sheets as cover or any other similar material readily available.

Besides' research, on dehydration, preservation and popularization of the technology was initiated in collaboration with Ayub Agricultural Research Institute, Faisalabad. As a result of this co-operation, the following work is completed or being completed during the year 1979-80.

Dr. M. Mameel Mehar, presenting his paper.

(a) Two 16 and 30 lbs. capacity solar ping-pong dryer with optimal technical and economical efficiency were got fabricated.

(b) Design of 4-5 lbs. Dryer are being evolved to utilize partly or wholly the kitchen stove heat recycling as well as natural gas.

In addition, training programme in the art and science of dehydration of fruits and vegetables has also been undertaken to popularize the technology in the rural areas. In the beginning the district of Faisalabad and Gujrat were selected for this purpose. Latter on, this programme was extended in the areas of Murree Mianwali, Rawalpindi and Sargodha. So far, training to 40 agencies and 2000 individuals have been imparted on the subject.

Similarly PCSIR Laboratories of Peshawar has developed technology for the preparation of vinegar from over ripe dates. Brouchers has been brought out in this regards.

The Karachi Laboratories have perfected the technology to produce Jam and some other products from the premature dates which do not normally find good market,

Training programme was conducted at PCSIR Labs. Peshawar, on date vinegar production and representatives from Local Government of Azad Jammu and Kashmir and sind small Industries, Government of sind have received training on the subject. The same Laboratories also provided training in dehydration of fruits (Apricot) to people of Baluchistan, Skardu in Northern aseas of the country.

Apart from this, co-operation was also extended to the rural development and local Goverment Azad Jammu and Kashmir; Social Welfare Department of sind and Directorate of Industries Government of Azad Jammu and Kashmir. Similar co-operation was also extended to IRDP Gilgit and Baluchistan. These agencies were provided with 16 lbs. Capacity dehydration to extend this programme in their respective Organisation of the country through AARI for the establishment of commercial unit. Some of them have established such units and have started commercially production recently.

In the end it may be added that it is observed that peoples of the country are not used to dehydrated stuff as a result of this the acceptence of the technology is rather slow at the momeut. However once the taste for the dehydrated food is developed, there is a great potential for this technology. This will not only make possible the availability fruits and vegetables at cheaper rates but also in the off season.

RECOMMENDATIONS

1. For the wide spread extension of the technology, there is a great need that more comprehensive programmes may be launched to motivate people to adopt and practice this

...ing programme may also be arranged on the air as a ...
...ode of demonstration. This seems only possible when all the Agencies/Organisations enga-
ged in the development of the backward area should work in joint venture and extend full
cooperation to each other. Services of all the mass media may also be pressed into service
for this purpose.

2. Large dehydration units may be installed at Mandi level which should provide market faci-
lity to the small entrepreneurs of the rural areas.

3. Survey on the rural production and consumption of vegetable may be undertaken to asses
the levels of data much needed commodities.

4. Similar surveys needs to be carried out on the production and wastage of fruits so that
their surplus may also be preserved for human consumption.

TABLE-1

...ON AND REDUCTIONISTIC BIAS OF VARIANCE

Agencies	Percentage share in 2006	Percentage share in production
Bank	21	17
Farmers	31	37
Chillies	24	4
Others	24	42
Total	100	100

TABLE - II

PRODUCTION OF VEGETABLES IN PAKISTAN

years	Production (000 tond)	Annual Changes %
1967-68	1735	—
1968-69	1519	-13.35
1969-70	1410	-7.18
1970-71	1600	-13.48
1971-72	1780	-11.25
1972-73	1872	-5.17
1973-74	1923	-2.72
1974-75	1959	1.87
1975-76	1816	-7.30
1976-77	1617	-10.96

TABLE - III

Fruits	Percentage share in area	Percentage share in production.
Citrus fruits	33	35
Mango	28	31
Dates	12	9
Gnava	9	7
Banana	7	7
Apple	4	3
Others	7	8
Total	100	100

TABLE -IV

TABLE SHOWING VARIATION OF VEGETABLE IN FAISALABAD MARKET DURING APRIL 1970 TO APRIL 1980

S.NO.	Name of Vegetable	Minimum rate per 100 kg.	Maximum rate	Ratio
1.	Potato	20		
2.	Onion	50	160	
3.	Garlic	24	400	1:6
4.	Ginger	15	240	1:6
5.	Bottlegourd	30	260	1:7
6.	Lady's finger	60	0180	1:01
7.	Peas	120	0300	1:02
8.	Tomato	20	700	1:16
9.	Spinach	20	420	1:5
		20	520	1:6
			520	1:6

SOURCE:

Rates supplied by the Market Committee, Faisalabad.

TABLE - V

PRICE INDICATION OF WHEAT

Year	Wheat (Per 100 kg)	Variation in Percentage
	Rs.	%
1970	1970	11.24
1971	1971	3.70
1972	1972	4.44
1973	1973	1.31
1974	1974	3.73
1975	1975	11.44
1976	1976	0.74
1977	1977	2.81
1978	1978	1.10
1979	1979	
1980	1980	

SOURCE:

Agriculture Statistics of Pakistan 1979 & 80, Government of Pakistan, Ministry of Food & Agriculture & Rural Development, Agriculture Wing, Planning Unit, Islamabad

MICROBIOLOGY ON WATER AND ITS VITAL ROLE IN CANNING OPERATIONS

By

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and

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INTRODUCTION

we are an argiculturist country and our economy is based on agricultural produce. Therefor the preservation of food for hungry mouth is essential. The spoilage is criminal and should be avoided with scientific skills available to us.

The canning industry engaged in preservation of food is confronted with many problems of spoilage due to non availability of technical skills available with many caners in the country. The post process spoilage is very collosal. The article deals with the prevention of Spoilage at this stage.

Microbiology of water and its vital role in canning operations

It is true that 'water is a carrier of diseaseas'. Water being solvent of most substances dissolves many minerals and other useful and harmful mateials. Water being the main constituent of the body and is consequently a necessary article of diet and should receive a scientific approach to decide its standard qualities. Quality wise, much depends upon the source, water for drinking purposes is obtained from various sources and is devided according to its origin in to two main types e.g.

a) Surface

b) Deep strata.

a) Surface water comprises of those collected at or near the surface of the ground and includes rain lakes, rivers and artificial or natural reserviors. This types is exposed to

contamination from many sources and is invariably contains various harmful bacterial population which serious disease of epidemics like cholera, typhoid, etc.

b) Deep water are collected from an underground source such as wells and springs. The water undergoes a process of filteration during percolation through the soil and is usually bacterial free at the source, except otherwise infected.

Surface water are the main sources of drinking water on account of their accessibility. Such water as previously stated always contains bacteria, the common saphrophytes being invariably present. Lakes and rivers are often heavily contaminated as they receive the drainage from the neighbouring land and are sometimes used for the disposal of sewage. when sewage is disposed off other means, sewage and water systems may run close together and fractures and leakages in the pipes have resulted in contamination of the water supply. It therefor, follows that presence of pathogens organisms are not uncommon in this type of water. As in some districts it is consumed an untreated state, it may be responsible for serious out-breaks of infections, the most important of which are those involving th intestinal tract, especially enteric fever, dysentry cholera and infective Hepatitis. Many such epidemics have been reported in which the drinking water has been the vehicle of infection. The water supply of large towns is either brought from remote regions, many away or is collected from local rivers and subjected to purification and filteration. In rural areas, however, drinking water is frequntly obtained from shallow wells situated close so dwelling places and is exposed to faecal contamination, of birds and these supplies do not usually confirm, with the accepted bacteriological standards for drinking water. There is thus a definite necessity for rigid control on drinking and food processing water.

The suitablity of water supply is determined by four types of analysis.

a) The chemical analysis determines total solids, hardness, etc. Excessive or unwanted minerals are removed by installing in exchange deminers, because mineral lisers deposits on equipments and boilers cause great harm, reducing their working life,

b) The physical examinatian determined if the water has any objectionable turbidity, colour taste or odour,

c) The biological analysis detects algae, fungi, protozoa, nematode, worms the smaller species of crustacea, and larva of aquatic insects.

d) The bacteriological analysis is the most valuable examination and is vital in preventing epidemics as a result of pollution. The bacteriological examination of water usually involves :

1. Estimation of the number of bacteria as determined by total plate count.
2. The more significant detection of the presence or absence of the members of the coliform group. Finding these organisms in a water supply is taken as evidence of fascal contamination and therefore of possible presence of the intestinal

pathogens causing typhoid fever, paratyphoid fever, dysentry an cholera. Few methods suggested by standard methods of the American Public Health Association are given below :

PREPARATION FOR TESTING

Collection of Specimen :

The recommended container is a colorless, wide-mouthed glass bottle with ground-glass stopper. The specimen should be a representative sample and should be examined with the least possible delay. For impure waters, the maximum time lapse is 5 hours ; for relatively pure waters, 12 hours. Samples should be stored at 6/10°C. In testing water from swimming pools, 20-50 mg. sodium thiosulfate is added to the sample bottle to neutralize the residual chlorine and prevent it from destroying bacteria in the interval between collection and testing.

Materials :

All glassware should be sterilized in a drying oven at 170°C. for 1 hour unless otherwise indicate.

1. One ml. pipettes, plugged with nonabsorbent cotton-
2. Test tubes. These are 5×5/8 inch test tubes, to which 0.5 ml. of tap water are added, and which are sterilized in the autoclave at 15 pounds pressure for 30 minutes and then cooled to room temperature. After sterilization, each tube should have exactly 9.0 ml. in it. If the water is below or above the mark, either add sterile water or remove a portion.
3. Sterile corks. If 5×5/8 inch test tubes are used, a number 5 cork will exactly fit. Prepare one cork for each test tube. The corks may be sterilized by boiling for 20 minutes in water, or by wrapping each cork separately and sterilizing in the hot air oven at 170°C, for two hours.
4. Dilution bottles or test tubes with close-fitting round-gladd or rubber stoppers.
5. Petri dishes, 10 cm. in diameter.
6. Fermentation tubes.
7. Suitable media should be chosen.

Dilutions :

All dilutions of the water specimens must be accurate and made with sterile precautions. A sample dilution scheme follows :

1. Shake the specimen bottle vigorously 25 times.

Representative from Hashmi Can Company, presenting his paper.

2. Make a 1 : 10 dilution of the water by adding 1 ml. of the water specimen to 9 ml. of sterile water in a test tube.

3. Then place a sterile cork carefully in the test tube to replace the cotton plug. Shake vigorously 25 times.

4. Make a 1 : 100 dilution of the water by adding 1 ml. of the water specimen diluted 1 : 10 to 9 ml. of sterile water.

5. Replace the cotton plug with a sterile cork and mix as in 6.

6. Make a 1 : 1000 dilution of the water adding 1 ml. of the water specimen diluted 1 : 100 to 9 ml. of sterile water.

7. Replace the cotton plug with a sterile cork and mix as in 3.

8. Dilutions may also be made by adding 10 ml. of the water sample or previous dilution to 90 ml. of sterile water in dilution bottles. A fresh pipette is used for each successive dilution.

PLATE COUNT

Prsparing the Plates.

The procedure for preparing plates to be used for counting is as follows:

1. Within 20 minutes after dilutions are made, transfer 0.5 ml. of the sample and each of the dilutions to appropriately marked Petri dishes.

2. Add 10 ml. liquefied and cooled nuterient agar, tryptone glucose extract agar, or gelatin. Mix thoroughly. Allow to solidify.

3. Invert and incubate in dark, well ventilated incubators practically saturated with moisture, at 20°C. for 48 hours and 37°C, for 24 hours. Gelatin plates are incubated at 20°C. only.

Counting

After the incubation period, the colonies are counted with a lens having a magnification of 1-1/2" diameters. Select the plates in which the colonies of bacteria number between 30 and 300. (It may sometime) be necessary to count plates with fewer than 30 colonies, as 1 ml. is set as the maximum amount of water to be used in preparing plates). At least two plates should be counted. Multiply the number of colonies counted, rounded out to two significant figures, by the dilution of the water. Take the average and report the result as the number of bacteria in each ml. of undiluted water for each incubation temperature.

Suppose, for example, that 343 colonies are counted on the plate containing 1 ml. of the water specimen diluted 1 : 10, 45 on the plate containing the 1 : 100 dilution, and 6 on the plate

containing the 1 : 1300 dilution. The number of bacteria reported (each colony being counted as one bacterium) per ml. of undiluted water will be :

$$340 \times 10 = 3400$$

$$45 \times 100 = 4500$$

$$\frac{7900}{2} = 4000 \text{ bacteria per ml of undiluted water.}$$

Interpretation

The maximum number of bacteria allowable for safe water is not set in Standard Methods, but is generally accepted to be 100 percent ml. at 37°C. The organisms normally found in water, grow best at 20°C ; the caliform organisms, at 37°C. If the total counts at the two temperature approximate each other, there is a strong suspicion that sewage bacteria are present. One of the greatest values of routine total counts is the rapid spotting of sudden pollution as indicated by a sharp rise above the count usually obtained from the same source.

TEST FOR PRESENCE OF MEMBERS OF THE COLIFORM GROUP

Preliminary Considerations :

1. The coliform group includes all aerobic and facultative anserobic Gram-negative-forming Bacilli which ferment lactose with gas formation.
2. Formation of gas in a standard 0.5% lactose broth fermentation tube within 24 hours at 37°C. is presumptive evidence of the presence of members of this group.
3. The appearance of aerobic, lactose-splitting, typical Escherichia coli colonies on Endo or Eosin Methylene Blue plates, made from a Lactose broth fermentation tube in which gas has has formed, or the formation of gas within 48 hours at 37°C. in a fermentation tube container Brilliant Green Lactose Bile Broth which has been seeded from a Lactose Broth fermentation tube in which gas has formed, constitutes a confirmatory test.
4. Demonstration that one or more aerobic plate colonies consist of Gram-negative, non-spore-forming Bacilli which form gas when inoculated into a Lactose Broth fermentation tube it a completed test,

Presumptive Test :

1. Inoculate a series of Lactose Broth fermentarion tubes with appropriate graduated quantities of the water to be tested. The concentration of ingrdients in the final mixture of medium and sample must be maintained as is indicated in the formula for standard Lacrose Broth, except that 1 ml. or less of sample may be added to 10 ml. single-strength Lactose Bioth. Multiple strengths of the media may be employed as necessary.

2. Incubate the tubes at 37°C. for 48 hours,
3. Examine each tube at 24 and 48 hours for gas formation.

A positive presumptive test is indicated by the formation of gas within 24 hours.

Besides the Coliforms, a positive presumptive test may be attributable to Clostridium perfringens, yeasts, or the synergistic combined action of two organisms,

A doubtful test is indicated if gas is observed at the end of 48 but not 24 hours. In this case the confirmed and complete tests should be performed.

Confirmatery Test :

1. For this test, use all the Lactose Broth fermentation tubes showing gas or the ones made from the two highest dilutions,
2. From each of these, streak one or more Endo or Eosin Methylene Blue plates and incubate at 37°C. for 24 hours, or inoculate Brilliant Green Lactose bile Broth fermentation tubes and incubate at 37°C. for 49 hours.

Plates : If, within the incubation period, typical Escherichia coli colonies develop (distinct red on Endo, metallic green on eosin methlene blue), the confirmed test is considered positive. If only a typical colonies develop, the test cannot be considered definitely negative, since of often happens that members of the coliform group fail to form typical colonies on these media, or that colonies develop slowly. In this case, proceed with the completed test.

Tubes

Gas formation consitutes a positive confirmed test. If decolorization occurs (probably due to Clostridium welchii), proceed with complete test.

Complete Test

1. This test may be performed on lactos broth fermentaion tubes showing gas' colonies found on plates for confirmed test, or Brilliant Green Lactoes Bile Broth tubes showing gas for confirmed test.
2. If using one of the broths, streak one or more Endo or eosin methylene blue plates and incubate at 37°C. for 24hours'
3. From each of the plates used for the confirmed test or from those prepared in step above, fish typical colonies likely to be coliform organisms and inoculate agar slant and Lactose Broth fermentation tube. Incubate at 37°C. for 24-48 hours,

The formation of gas in the actose broth and the demonstration of typical Gram-negative, non-spore forming Bacilli in the agar culture constitute a satisfactory completed test, demonstrating the presence of a member of the cliform group. The absence of gas formation in the lactose broth

tube, or the failure to demonstrate Gram-negative, non-spore-forming bacilli in a gas-forming culture, constitutes a negative test.

If spore-forming, Lactose-fermenting organisms are found, transfer to Formate Ricinoleate Broth and incubate at 37°C. for 48 hours. If no gas is produced, the conclusion is that only per-formers are present. If gas is produced, coliform organisms are probably present- In this case, inoculate standard lactose broth fermentation tubes and agr slants from the formate ricinoleate. If gas is produced in the lactose broth and formed in the agar slant, the test is considered positive. If spores are present, coliform organisms are considered absent.

WATER PURIFICATION

It is estimated that 10-40 %of the total cases of typhoid are a result of water contamination. In cities with efficient with purification systems,however' typoid and other diseases such as cholara resulting from contaminted water have practically vanished. The methods of purifying water are briefly noted below.

Natural Purification

Natural or self-purification of water is brought by distillation, sedimentation, oxidation including the action of light, and filgration.

Artificial Purification

The methods of treating a water which is unsafe for human consumption may be summarized as follows (after Jordan and Burrows).

1. Mechanical :
   a) Storage
   b) Filtration
   c) Slow sand filtration
   d) Coagulation and rapid sand filtration.
2. Chemical - almost exclusively with chlorine-yielding substances.
   a) Large Scale - hypochlorites and liquid chlorine.
   b) Small Scale - hypochlorites, ultraviolet light, ozone, special chlorinated compounds, etc.

Frequently a combination of filtration and chlorination is employ.

For the family or individual, when using an impure water supply or when water-borne disease is prevalent, boiling for 5 minutes is a simple and efficient means of destroying all the intestinal pathogens.

POST PROCESS COLLING WATER

As the conclusion of heat processing of canded foods, process of cooling the cans is a very important operation. It is definitely established that when cans are allowed to cool in water carrying high bacterial population, a greater proportion becomes spoiled, than when the water is of potable quality. This establishes firmly that water used in a cannery should be of standard potable quality. The degree of bacterial contamination in the cooling water would be of little or no significance if it were possible to manufacture, close and handle in a manner that would ensure a perfectly sealed container, when the cans were delivered to the cooling sprays or tanks. Such a thing is impracticable under normal working conditions in a cannery. The ideal conditions of cooling cans are not found it most canneries and cooling has not received proper attention of canners, although it is of prime importance. In the formation of double seam, metal from the flange on can body is interlocked by a rolling operation with the edge of the end cover, and spaces between the layers of tinplate in the joint or seam thus produce being led with a rubber or similar compound, previously deposited in a thin layer on a specially designed recess at the periphery of the cover. Such a material acts like a gasket and makes the can seam leak proof. To achieve an hermatic seal seams are produced within a specified limit of tolerances beyond which it is impossible to have commercial production of cans. To describe the ingress of bacteria through seam we should consider the size of bacteria. The bacteria vary in size and may be as small as 1/12500 of an inch (0.2μ), the majority being about 1/50000 of an inch in width (0.1μ), while the engineers cannot control the dimensions of seam to less than 5/1000 of an inch between the layers of the metal. If, therefore, a seam should have a gap of 5/1000 between the layers of metal of which it is made micro-organisms of this size and less could pass through the gap (free space) into the can. The function of the lining compound is to prevent this entry and in fact in most seams does so, but it is believed that the continuity of the liner or the formation of the seam may become temporarily disturbed from a variety of factors during the filling of the cans, and subsequent operation, so that when such disturbances coincide and with the minute channel in the seam, the way is open for the passage of bacteria. The factors concerned are chiefly bound up with the pressures developed during retorting but also involved are the conditions of closing, the type of products in the can and rough handling of the closed container.

It is actually during the cooling period after the cans have been processed, that most favourable conditions are attained for micro-organisms to enter the can. As the temperature of the can and contents falls after cooling the internal pressure built up during processing are relieved and a vacuum is gradually created and it is only then that infect droplets of water may be drawn into the can. The amount of water entering is, however extremely small and will in no way affect the vacuum but coloured waste caused by the contamination is very great. It infers that fnity of minute quantity of cooling water is not of material value in the product than the degree of bacterial count present in it. The larger the number of bacteria per unit volume of water are the changes of their being carried into the can and consequent spoilage due to bacterial development inside the can. Spoilage outbreaks due to heavily infected cooling water have been experienced both in this country and countries like U. K. & U.S.A. Canning experts have now established that cooling water should

not contain more than 50 viable organism per each millitre. The fact that the bacterial count of cooling water will effect the amount of spoilage in canned found goes back to an American research work in 1931. Snoot (1937), Merrill (1938) publishe results of their observation in respect of cooling water infection. Merrill reported spoilage in a pea pack was found to drop from 23% of can processed to less than 2 can per 1000 packed on changing from water containing 5½ million organisms per ml. to a clean and low count supply. This further established the necessity to reduce bacterial population of can cooling water by various methods out of which chlorinatoin proved economical and successful and standard of 100 organisms per ml. was regarded as safe working limit.

A table below shows the results of observations made during one year with water as received at a certain cannery and the same water after chlorine treatment. A variety of packs were investigated amounting to a total of over 40,000 cans.

Although a full account of bacterial content of water at every stage is not available, but chlorinated water contained organisms in the order of 500,000 per ml.

EFFECT OF COOLING WATER INFECTION ON SPOILAGE IN CANNED FOODS
Blown cans per 1,000 packed.

Product	Can Size (OZ.)	Ordinary Water	Chlorinated Water	No. of Cans tested
Marrowfat peas	30	5.7	1.4	1,400
Salad beans	16	0.8	0.0	7,200
Runner Beans	30	0.3	0.3	5,700
Baked beans	16	7.0	2.5	4,800
Potatoes	30	2.5	1.4	16,000
Blue peas	(10) (20)	6.2	2.7	5,000
Blue Peas	30	22.0	12.8	1,700

Scott carried out some of the earlier work on this sterilising question, and his findings are of interest. He added canned corn to water carrying the normal bacterial infection of the cannery water, and compared the number of blown cans obtained with those from batches cooled in the same water having a residual chlorine content of 5 to 15 parts per million, the chlorine reducing the bacterial count to 2 - 3 organisms per 1 millilitre of the treated water. His results serve to illustrate the degree of spoilage which may occur when grossly infected water is used.

Blown Cans per 1000

Can Size	Product	Chlorinated Cooling Water	Non-chlorinated Cooling Water
30	Marrowfat peas	1.4%	5.7
16	Salad beans	0.0	0.8
30	Runner Beans	0.3	0.3
16	Baked beans	2.5	7.0
30	Potatoes	1.4	2.5
(10) (20)	Blue peas	2.7	6.2
30	Blue Peas	12.8	22.0

INPLANT CHLORINATION

After establishing that water from all possible sources is contaminated, it becomes useful [illegible] to chlorinate the water in the plant itself to bring bacterial population to a desired level. Before describing the process of chlorination, we should have proper storage facilities which may help to eliminate the change of stagnation and further development of bacteria and algae. To illustrate the point water and cooling tanks should be made at least of two units, that there may be some alternatively. In the ground tank algae and [illegible] could be removed, algae and fungi could be killed by the treatment of dilute solution of copper sulphate and subsequent flushing with water or similar treatment will eliminate unwanted mineral deposits on equipment and will increase the working life.

The process of chlorination is carried out by the addition of solutions of sodium hypochlorite, bleach solution and several other chlorine compounds. Amongst host of such chlorine compounds is stable tropical chloride of lime produced by I.C.I. and marketed under brand name Chlorosene and is similar in comment with overhead tank. If an ion exchange demineraliser is available then Sanaclor A is widely used for inplant chlorination. It contains about 24.26% available chlorine and has long storage life even under severe tropical conditions. The exposure to sunlight and water lowers the chlorine content.

The limit of chlorine content in a cannery water is a matter of practical necessity. The organic matter dissolved through cans or any other sources keep on reducing the chlorine content. The limit of chlorination will then depend upon expert guidance of water treatment specialist. Some authors prescribe a basic limit of 1 to 2 parts p. p.m of residual chlorine with a contact period of 15 to 30 minutes for lethal disinfection. Baungartner prescribes 5 p. p.m as lower limit for cannery cooling water. In U.S.A. 5-7 p. p.m. is being maintained, but as O.C. only 1 to 2 parts are found to be sufficient. To keep this limit, a continuous check on cooling water is necessary. Also the chlorine analytical procedure is described latter. Primarily the water is treated by chlorinator, however, the chlorine estimated by the chart provided by the supplier (B.D.H.) alongwith the machine.

The analytical method for estimating chlorine content in original solution of [illegible] is described later.

As a guideline, a dosage schedule is also given below, which should be followed for chlorination of water.

One part per million available chlorine.

= ½ oz. bleaching powder in 1989 gallons of water.

= 1 lb. " " 53000 " "

= 2 lb. " " 86000 " "

= 5 lb. " " 100000 " "

= 50lb. " " 1000000 " "

The above schedule is based on 34 - 36% of chlorine content in bleaching powder and will need readjustment if the percentage differs.

The practical method of chlorination is to make strange solution of bleaching powder in earthen ware jars, glass bottles. The solution is vigorously mixed and supernatant liquid is allowed to mix in bulk tanks.

METHOD FOR ESTIMATING RESIDUAL CHLORING IN WATER

Reagent :

1 g. pure otolidine (B.D.H.) is dissolved in 150 mL concentrated hydrochloric acid and made up to a litre with distilled water.

The otolidine should be ground in a pestle and mortar with 5-10 ml. acid: the resulting thin paste dissolves readily on adding about 250 ml. distilled water. Alternatively the soultion can be obtained from suppliers of laboratory chemicals or from certain chlorine manufacturers.

Apparatus :

B.D.H. comparator and or Nesleriser together with the appropriate o-tolidine colour discs.

Procedure :

The procedure consists essentially of adding o tolidine reagent to the water sample in the proportion of 1 .0 ml. of reagent/100L of sample and obtaining the reading on the appropriate disc both immediately (i.e. a 'flash' test) and after the sample has stood for 5 minutes. If the sample is particularly alkaline, it is sometimes necessary to wait 10 minutes for a full colour development.

In this method the first test measures the free chlorine present and the second gives the tota of both the free and combined chlorine.

The method is liable to interference from such impurities as 0.2 ppm nitrite, 0.01 ppm manganese, etc. but a rough correction can be made by performing blank tests and subtracting the figures obtained from those in the original tests.

The blank test is performed by dechlorinating the simple with 0.5 ml 0.5% sodium arsenite solution before adding the o-tolidine reagent.

METHOD FOR THE DETERMINATION OF AVAILABLE CHLORINE IN STABUCHLOR A AND CHLOROSENE

Reagents :

The reagents used shall be of recognised analytical reagent quality.

(a) Sodium bicarbonate.

(b) Sydium Arsenite, 0.1 N solution.

(c) Potassium iodide, 5 percent solution.

(d) Starch, 1 percent solution.

Preparation of Sample :

Crush a suitable quantity of the material in a warm dry mortar and pass it through a 10 mesh B S. test sieve. Perform this operation with a minimum of delay.

Procedure :

Accurately wiegh about 3g. of the material into a small glass mortar and rub it to a cream with 15 to 20 ml. of tepidt distilled water using a glass pestli. The temperature of the water should not exceed 40°C (If the mixture sets to a stiff gel during the creaming operation, discard this portion and start again, using slightly more water). When the material is thoroughly dispersed, add cold distilled water to a total volume of about 100 ml: Allow any lumps or coarse particles to settle and decant the turbid liguor into a 500 ml. graduated flask. Continue grinding the residue with further quantities of water, decanting the supernatant liguor into the 500 ml. flask, until only insoluble gritty matter remains. Mak up the volume of the liguor to 500 ml. with water at room temperature and shake thoroughly.

Carry out a preliminary test as follows;

Measure 50 ml. of the well-mixed suspension into a beaker containing 0.5 kg. of sodium bicarbonate. Titrate with the sodium arsenite solution until a drop of the liquid produces no iodine colouration when allowed to fall on a drop of the potassium iodids solution on a with tile. Add 1 ml. of the potassium iodide solution to the beaker and proceed with the titration until the iodine colour disappears. Only 1 to 3 drops of arsenite solution should be required at this stage.

The approximate amount of sodium arsenite solution required now being known, the test should be repeated ie the following manner.

Run into a small beaker an amount of the sodium arsenite solution, less by 0.1 ml. than the amount found in the preliminary test, Add, 50 ml. of the bleach suspension, together with 0.5 g. of

sodium bicarbonate and 1 ml. of the potassium iodide solution and titrate with the sodium arsenite solution until the color due to the liberated iodine just disappears, adding 0.5 ml. of starch solution at the end of the titration to verify its completion.

Calculation

Available chlorine, Cl, percent.

$$= \frac{3.546T}{W}$$

Where T = volume in millilitres of 0.1N sodium arsenite used

and W = weight in grammes of bleaching powder taken for the test.

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